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FARMINGTON RIVER BASIN
HARTLAND, CONNECTICUT

**GOODWIN DAM
CT. 00541**

**PHASE I INSPECTION REPORT
NATIONAL DAM INSPECTION PROGRAM**

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**DEPARTMENT OF THE ARMY
NEW ENGLAND DIVISION, CORPS OF ENGINEERS
WALTHAM, MASS. 02154**

SEPTEMBER 1978



DEPARTMENT OF THE ARMY
NEW ENGLAND DIVISION, CORPS OF ENGINEERS
424 TRAPELO ROAD
WALTHAM, MASSACHUSETTS 02154

REPLY TO
ATTENTION OF

NEDED

Honorable Ella T. Grasso
Governor of the State of Connecticut
State Capitol
Hartford, Connecticut 06115

NOV 30 1978

Dear Governor Grasso:


I am forwarding to you a copy of the Goodwin Dam Phase I Inspection Report, which was prepared under the National Program for Inspection of Non-Federal Dams. This report is presented for your use and is based upon a visual inspection, a review of the past performance and a brief hydrological study of the dam. A brief assessment is included at the beginning of the report. I have approved the report and support the findings and recommendations described in Section 7 and ask that you keep me informed of the actions taken to implement them. This follow-up action is a vitally important part of this program.

A copy of this report has been forwarded to the Department of Environmental Protection, the cooperating agency for the State of Connecticut. In addition, a copy of the report has also been furnished the owner, the Metropolitan District of Hartford County, 555 Main St., Hartford, Connecticut 06100.

Copies of this report will be made available to the public, upon request, by this office under the Freedom of Information Act. In the case of this report the release date will be thirty days from the date of this letter.

I wish to take this opportunity to thank you and the Department of Environmental Protection for your cooperation in carrying out this program.

Sincerely yours,


JOHN P. CHANDLER
Colonel, Corps of Engineers
Division Engineer

Incl
As stated

UNCLASSIFIED

SECURITY CLASSIFICATION OF THIS PAGE (When Data Entered)

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20. ABSTRACT (Continue on reverse side if necessary and identify by block number) The Goodwin Dam is an earth embankment and rock embankment with an earth core that is 800 feet long and 125 feet high. It has an emergency spillway, channel gate house and diversion tunnel. The dam and its appurtenant structures are in good condition. The dam will pass the PMF without overtopping the dam.		

GOODWIN DAM

CT 00541

FARMINGTON RIVER BASIN
HARTLAND, CONNECTICUT

PHASE 1 INSPECTION REPORT
NATIONAL DAM INSPECTION PROGRAM

NATIONAL DAM INSPECTION PROGRAM

PHASE I INSPECTION REPORT

Identification Number:	CT 00541
Name:	Goodwin Dam
Town:	Hartland
County and State:	Hartford County, Connecticut
Stream:	West Branch of the Farmington River
Date of Inspection:	June 1, 1978

BRIEF ASSESSMENT

The Goodwin Dam is an earth and rock embankment with an earth core that is 800 feet long and 125 feet high. It has an emergency spillway, channel, gate house and diversion tunnel. The dam and its appurtenant structures are in good condition.

The dam will pass the Probable Maximum Flood (recommended Spillway Design Flood) without overtopping the dam.

Some recommended measures, as described in Section 7 to be undertaken by the owner, should include the establishment of metering points for seepage measurement and periodic inspections of the dam. It is not urgent to implement these recommendations. However, it is recommended that the owner implement them within two to three years after receipt of this Phase I Inspection Report.

Joseph F. Merluzzo
Joseph F. Merluzzo
Connecticut P.E. #7639
Project Manager

Richard F. Lyon
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Project Engineer

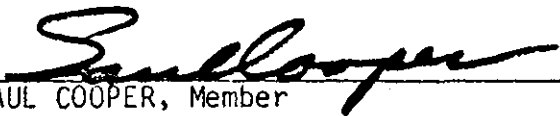
This Phase I Inspection Report on Goodwin Dam has been reviewed by the undersigned Review Board members. In our opinion, the reported findings, conclusions, and recommendations are consistent with the Recommended Guidelines for Safety Inspection of Dams, and with good engineering judgment and practice, and is hereby submitted for approval.



CHARLES G. TIERSCH, Chairman
Chief, Foundation and Materials Branch
Engineering Division

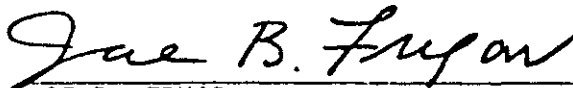


FRED J. RAVENS, Jr., Member
Chief, Design Branch
Engineering Division



SAUL COOPER, Member
Chief, Water Control Branch
Engineering Division

APPROVAL RECOMMENDED:



JOE B. FRYAR
Chief, Engineering Division

PREFACE

This report is prepared under guidance contained in the Recommended Guidelines for Safety Inspection of Dams, for Phase I Investigations. Copies of these guidelines may be obtained from the Office of Chief of Engineers, Washington, D.C. 20314. The purpose of a Phase I Investigation is to identify expeditiously those dams which may pose hazards to human life or property. The assessment of the general condition of the dam is based upon available data and visual inspections. Detailed investigations and analyses involving topographic mapping, subsurface evaluations, testing, and detailed computational evaluations are beyond the scope of a Phase I Investigation; however, the investigation is intended to identify the need for such studies.

In reviewing this report, it should be realized that the reported condition of the dam is based on observations of field conditions at the time of inspection along with data available to the inspection team. In cases where the reservoir was lowered or drained prior to inspection, such action, while improving the stability and safety of the dam, removes the normal load on the structure and may obscure certain conditions which might otherwise be detectable if inspected under the normal operating environment of the structure.

It is important to note that the condition of a dam depends on numerous and constantly changing internal and external conditions, and is evolutionary in nature. It would be incorrect to assume that the present condition of the dam will continue to represent the condition of the dam at some point in the future. Only through continued care and inspection can there be any chance that unsafe conditions be detected.

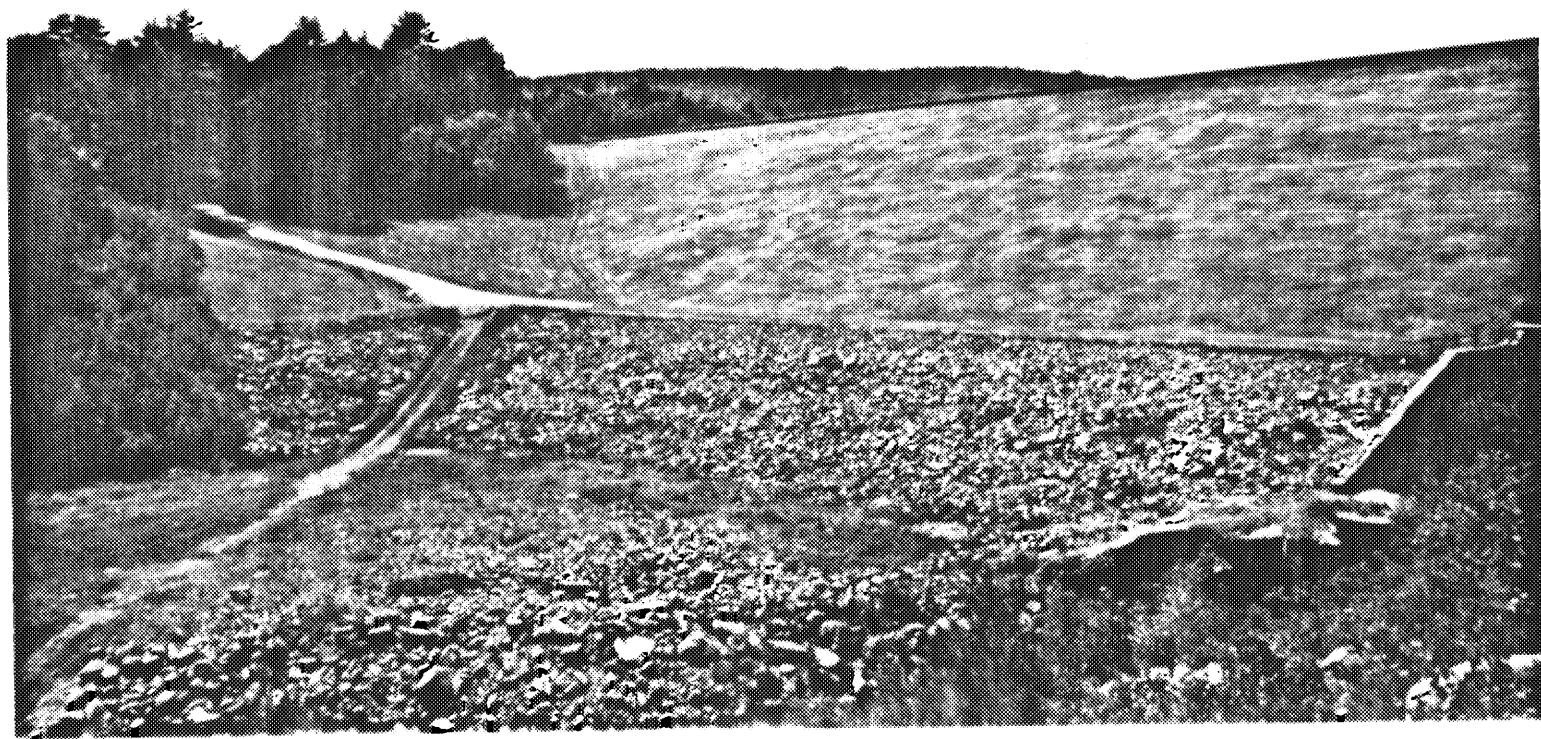
Phase I Inspections are not intended to provide detailed hydrologic and hydraulic analyses. In accordance with the established Guidelines, the Spillway Test Flood is based on the estimated "Probable Maximum Flood" for the region (greatest reasonably possible storm runoff), or fractions thereof. Because of the magnitude and variety of such a storm event, a finding that a spillway will not pass the test flood should not be interpreted as necessarily posing a highly inadequate condition. The test flood provides a measure of relative spillway capacity and serves as an aide in determining the need for more detailed hydrologic and hydraulic studies, considering the size of the dam, its general condition and the downstream damage potential.

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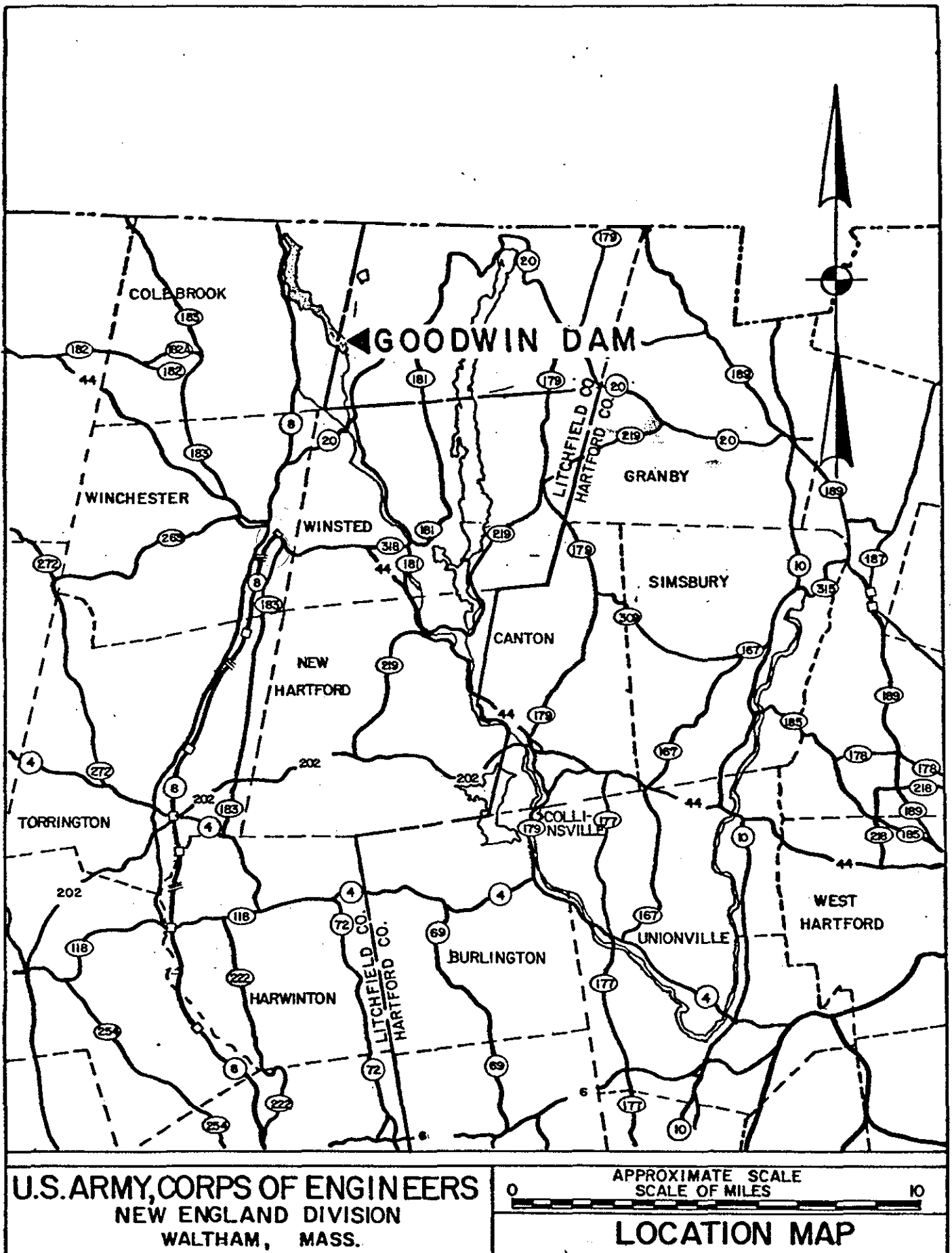
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OVERVIEW PHOTO - GOODWIN DAM (HOGBACK)



PHASE I INSPECTION REPORT

GOODWIN DAM CT 00541

SECTION 1 - PROJECT INFORMATION

1.1 General

a. Authority - Public Law 92-367, August 8, 1972, authorized the Secretary of the Army, through the Corps of Engineers, to initiate a national program of dam inspection throughout the United States. The New England Division of the Corps of Engineers has been assigned the responsibility of supervising the inspection of dams within the New England Region. Storch Engineers has been retained by the New England Division to inspect and report on selected dams in the State of Connecticut. Authorization and notice to proceed was issued to Storch Engineers under a letter of May 3, 1978 from Ralph T. Garver, Colonel, Corps of Engineers. Contract No. DACW33-78-C-0000 has been assigned by the Corps of Engineers for this work.

b. Purpose -

(1) Perform technical inspection and evaluation of non-Federal dams to identify conditions which threaten the public safety and thus permit correction in a timely manner by non-Federal interests.

(2) Encourage and assist the States to initiate quickly, effective dam safety programs for non-Federal dams.

(3) To update, verify and complete the National Inventory of Dams.

1.2 Description of Project

The Goodwin Dam is one of 18 dams owned and operated by the Metropolitan District of Hartford County, Connecticut. The structure is an earth and rock fill embankment with an earth core. The dam is 800 feet long and 125 feet high (Plate 1). It has an emergency spillway and channel, a gate house and diversion tunnel. The facility impounds the West Branch Reservoir and serves as compensating water for riparian owners. The reservoir will also be used as water supply when the demand in the Hartford area warrants it. This will be accomplished by connecting it to the Barkhamsted Reservoir by a tunnel.

The dam is located in the Town of Hartland, Hartford County, Connecticut (See Location Map) and is approximately 22 miles northwest of Hartford, Connecticut. The dam is also located on the West Branch of the Farmington River, in the Farmington River Basin.

The size classification of the dam is large (125 feet high and 7,140 acre feet storage) and the hazard classification is high per the criteria set forth in the Recommended

Guidelines for Safety Inspection of Dams by the Corps of Engineers. The immediate downstream area that will be affected by the dam's failure as shown in Appendix D, Plates 6, 7 and 8 includes portions of Riverton, New Hartford, Collinsville and Unionville as well as numerous homes and farms along the river banks.

The Goodwin Dam was designed by the Engineering Section of the Metropolitan District under the direction of Warren Gentner, Chief Engineer. Several consultants such as Karl Terzaghi, Charles Berkey, Leo Casagrande, David Wiggin and Karl Kennison were retained as experts for the design. Model tests of the spillway and channel were performed in 1954 by the Alden Hydraulic Laboratory of the Worcester Polytechnic Institute (Appendix B, Page B-1, Reference 2).

The dam was constructed between the years 1955 and 1960 by White Oak Excavators, Plainville, Connecticut.

There is a regular staff of maintenance personnel available. The items that are scheduled for regular maintenance include the cutting of grass on the embankment of the dam, servicing of the gate house equipment and inspection of the diversion tunnel.

The person in charge of day to day operation of the dam is Irv Hart, MDC Supply Division Headquarters, Beach Rock Road, Barkhamsted, Connecticut; Telephone No.: 379-0938.

1.3 Pertinent Data

a. Drainage Area - The 120.0 square mile drainage area that contributes to the West Branch Reservoir is a fairly broad watershed. The terrain is hilly and forested with some development. Of the 120.0 square mile drainage area, 118 square miles is controlled by the Colebrook Flood Control Dam which was completed in 1970.

b. Discharge at Damsite - Maximum known flood at the site which occurred prior to the dam's construction is 35,400 cfs, (August, 1955). Maximum Pond Elevation to date was 641.75 feet MSL and the discharge was 5,000 cfs.

(1) Outlet works (conduits) size:

2-24" and Invert Elevation 540.5

2-30" and Invert Elevation 540.0

2-36" and Invert Elevation 539.4.

(2) Maximum known flood at damsite 35,400 cfs.

(3) Ungated spillway capacity at maximum pool elevation: 92,000 cfs at 650.0 feet MSL.

(4) Gated spillway capacity at pool elevation N/A cfs at N/A elevation.

(5) Gated spillway capacity at maximum pool elevation N/A cfs at N/A elevation.

(6) Total spillway capacity at maximum pool elevation: 92,000 cfs at 650.0 feet MSL.

c. Elevation (Feet above MSL)

- (1) Top Dam: 659.0
- (2) Maximum pool-design surcharge (MDC): 650.0
- (3) Full flood-control pool: N/A
- (4) Recreation pool: N/A
- (5) Spillway crest: 641.0
- (6) Upstream portal invert diversion tunnel: 537.46
- (7) Streambed at centerline of dam: 524.0
- (8) Maximum tailwater: 562.0

d. Reservoir - Up to Colebrook Dam

- (1) Length of maximum pool: 7,500 feet
- (2) Length of recreation pool: N/A
- (3) Length of flood-control pool: N/A

e. Storage: (Acre-Feet) - Up to Colebrook Dam

- (1) Recreation pool: N/A
- (2) Flood-control pool: N/A
- (3) Design surcharge (MDC): 7,140±
- (4) Top of dam: 8,900±

f. Reservoir Surface (Acres) - Up to Colebrook Dam

- (1) Top of dam: 220.0±
- (2) Maximum pool: 220.0±
- (3) Flood-control pool: N/A
- (4) Recreation pool: N/A

(5) Spillway crest: 220.0±

g. Dam

(1) Type: Earth and rockfill embankment
with earth core

(2) Length: 800 feet ±

(3) Height: 125 feet ±

(4) Top width: 65 feet ±

(5) Side Slopes: Varies; U/S - 1:2.5 to 1:22

D/S - 1:2.5 to 1:2.4

(See Cross Section,

Appendix B, Plate 2)

(6) Zoning: See cross section, Appendix B, Plate 2.

(7) Impervious core: Earth

(8) Cutoff: Not less than four feet

(9) Grout curtain: 25 to 30 feet

(10) Other: N/A

h. Diversion and Regulating Tunnel

(1) Type: Concrete

(2) Length: 420 feet ±

(3) Closure: N/A

(4) Access: Upper gate house

(5) Regulating Facilities: Electrically operated
gates

i. Spillway

- (1) Type: Fixed weir (concrete)
- (2) Length of weir: 900 feet
- (3) Crest elevation: 641 feet
- (4) Gates: None
- (5) U/S Channel: Earth approach underwater -
five feet
- (6) D/S Channel: 1,700 feet rock channel
- (7) General: N/A

j. Regulating Outlets

Regulating outlets consist of two, 24 inch; two, 30 inch and two, 36 inch diameter pipes. There is also provisions for a future connection to Barkhamsted Reservoir.

- (1) Invert: 540.6, 540.0 and 539.4
- (2) Size: two, 24 inch; two, 30 inch respectively
- (3) Description: steel pipes
- (4) Control mechanism: Electrically operated gates
- (5) Other: N/A

SECTION 2 - ENGINEERING DATA

2.1 Design

The dam was designed by the Metropolitan District in conjunction with several well-known experts in the fields of geology, soils and hydraulics. In addition to the expertise, provided by these consultants, there have been a number of studies performed before, during and after the completion of construction in 1960.

During the design phase, the Metropolitan District conducted several studies concerning virtually every structural element of this dam. Dr. K. Terzaghi considered various sections for this design including a concrete core wall. In his report of April 2, 1952, (Appendix B, Page B-1, Reference 4) he pointed out that it would be a waste of money to provide the dam with a core wall unless this wall is designed in such a manner that it would remain intact in spite of the deflections which will be produced by the water pressure on its upstream face. The different designs and checks of the spillway and diversion tunnel for this dam was supplemented with a dam model test conducted by the Alden Hydraulic Laboratory at Worcester Polytechnic Institute (Appendix B, Page B-1, Reference 2) and reports by various other prominent consultants.

2.2 Construction

The dam was constructed between the years 1955 to 1960 by White Oak Excavators Construction, Plainville, Connecticut. It was constructed using an upstream and downstream cofferdam with a diversion tunnel sized to handle the August, 1955 flood. Appendix B, Plate Nos. 1-4 show the general features of the construction.

It was noted from conversations with personnel of the Metropolitan District that there were no unusual problems encountered during construction.

2.3 Operation

The diversion tunnel is operated only when it provides for downstream water supply. A water level indicator is monitored weekly in the gate house. Regulation of the water flow in the gate house is through stop logs and sluice gates.

The method of operation is basically manual requiring personnel attendance as needed to accommodate changing conditions or flow regulation. Manual operations are assisted by means of motor operators on the valves and an electrically operated bridge crane.

2.4 Evaluation

a. Availability - Design, construction and operation information is readily available. A list of references used to study the dam is contained in Appendix B of this report.

b. Adequacy - The information made available for this inspection along with the visual inspection, past performance history and hydrologic and hydraulic assumptions were more than adequate to assess the condition of the dam.

c. Validity - The validity of the information is not questionable and the history of the dam seems to bear this out.

SECTION 3 - VISUAL INSPECTION

3.1 Findings

a. General - The visual inspection for this dam was conducted on June 1, 1978 by members of the Engineering Staff of Storch Engineers and with the help of Peter Revill of the Metropolitan District. A copy of the visual inspection check list is contained in Appendix A of this report.

The following procedure was used:

1. The top and side slopes of the dam, appurtenant structures were inspected.
2. The banks in the downstream area were visually surveyed.
3. The upstream surfaces of the dam, outside of gate house and weir, as well as the banks of a reservoir were inspected.
4. The dam crest was visually surveyed.
5. Areas were checked for evidence of leaking, leaching or damage.
6. The dam and its appurtenant structures, as well as local places that had cracks, seepage and leaks were photographed.

7. Seepage discharges at the cracks, joints and drains were measured.

Before the inspection, the design, construction, operation and maintenance documentation and results of repair from prior inspections were compiled and studied. A compact sketch of the main structures was used for orientation during the period of inspection (Appendix B, Plate 1).

In general, the overall appearance and condition of the dam and appurtenant structures is good.

b. Dam - The downstream face of the dam was inspected for evidence of seepage on the surface. The surface appeared dry and the infra-red photographs taken to check for moisture showed no seepage. The underdrains for the seepage localization of the body of the dam exit at a point in the bed of the stream and could not be located.

The overview photo shows that the grass of the embankment is well maintained and free of any irregularities or bulges. In the area of the gate house, a parapet wall settlement of 4 to 5 inches was observed and appears to be normal for this location, however, there appears to be an increase from the Metropolitan District inspection results of 1973 when the settlements were 1 to 3 inches (Appendix B, Page B-1, Reference 6).

The visual inspection of the upstream riprap indicated it to be in excellent condition with no shifts or movements observed.

c. Appurtenant Structures - The spillway is a concrete weir on top of a ledge channel (Appendix C, Page IF-2) and is in good condition. The spillway channel condition is excellent and there are no evidences of loose rock or slippage of any ledge.

The inspection of the gate house and diversion tunnel showed that there is some minor leakage and leaching along the construction joints of the interior walls. At the time of the inspection, one, 24 inch diameter gate was partially open so minimum flow could be maintained. The resulting moisture in the tunnel was evident and at two construction joints and one vertical crack (Appendix C, Page II-4) flows were visible, approximately 4 to 6 gallons/minute from the joints and 2 gallons/minute from the crack. This seepage caused leaching of lime from the concrete.

At the end of the diversion tunnel there are two seepage pipes which penetrate the walls (Appendix C, Page II-5). The flow from the east drain is approximately 5 to 6 gallons/minute and the west drain approximately 0.05 to 0.1 gallon/minute. Also the seepage from the west drainage

pipe is accompanied by rusty, brown material which deposits on the surface of the tunnel wall.

In general, the remaining concrete of the tunnel is in good condition. A dehumidification system was installed to cut down the moisture in the gate house structure. The layout for the gate house is simple and as a result is fairly maintenance free.

d. Reservoir Area - An inspection of the upstream reservoir area showed that the riprap is in satisfactory condition with no evidence of shifting or repair. The area immediately upstream of the dam embankment seems to be in very natural state with no visible signs of erosion, sloughing or distress.

e. Downstream Channel - The spillway and downstream channel are cut into ledge rock (Appendix C, II-2 and II-3) and are in good condition. There is no visible erosion or sloughing of the floor or walls.

3.2 Evaluation

The visual inspection of this facility did not reveal any apparent areas of distress. The general condition of the dam and its appurtenant structures is good.

The seepage flows from the body of the dam could not be monitored because the underdrains were in the river bed and apparently inaccessible. The normal flow of water through the dam appears negligible. Surface cracks, embankment bulges, piping or boils were not observed.

SECTION 4 - OPERATIONAL PROCEDURES

4.1 Procedures

The responsibility for maintenance is with the Metropolitan District Commission. The maintenance staff is headquartered in a building located approximately 1/2 mile west of the dam. These personnel perform the necessary work needed to patrol the area for trespassers, mow the grass slopes and maintain the equipment in the gate house.

There is no written standard operating procedure for maintenance or emergency operating procedures.

4.2 Maintenance of the Dam

The maintenance of the dam is very consistent for the items mentioned above. The maintenance needed is minimal because of the capacity and type of construction of the spillway.

4.3 Maintenance of Operating Facilities

The overall maintenance of all the mechanical and electrical components of the Goodwin Dam facilities which could be observed appeared to be good with some notable exceptions. A "punch list" of these deficiencies will be provided to the Metropolitan District to use as they see fit.

Ventilation and high humidity appears to be an inherent problem in the lower level of the gate house and in the diversion tunnel. As a result, the dampness has corroded some of the miscellaneous steel at the lower levels. A dehumidification system was installed in the stairwell of the gate house to minimize the dampness. Electric power is used to operate the gates in the diversion tunnel, domestic lights and the heat and dehumidification system in the gate house.

4.4 Description of Warning System

There is no warning system in effect.

4.5 Evaluation

The maintenance or lack of maintenance of the diversion tunnel and controls will not jeopardize the safety of the dam since the capacity of the spillway precludes the hydraulic need for the diversion tunnel. The existence of the diversion tunnel is necessary only for the purpose of maintaining a minimum flow downstream during a dry spell or at other times as stipulated in Section 6.

SECTION 5 - HYDRAULIC/HYDROLOGIC

5.1 Evaluation of Features

a. Design Data - The 900 foot long spillway and multiple sluice gates in the diversion tunnel are the only means of transmitting water past the dam. As stated in Section 2, a model test was conducted on the spillway in 1954. This test gave important data to the designers concerning the characteristics of the spillway and determined its behavior during the design flood. A review of the calculations by the MDC indicates that the spillway is capable of passing the PMF. The design discharge for the spillway is 92,000 cfs.

b. Experience Data - The maximum flood to date at the site was the flood of August, 1955. During this flood, a flow of 35,400 cfs was experienced, however, since the dam was constructed, the maximum discharge was 5,000 cfs at elevation 541.75.

c. Visual Observations - The spillway and channel at the time of the inspection were in good condition. The gates are all in good condition as well as the diversion tunnel and outlet channel. The sluice gates in the diversion tunnel can be fully opened in the event of an emergency.

d. Overtopping Potential - The probable maximum flood would flow over the spillway (See Appendix B) at a depth of 9.0 feet, which is the design depth. This flow over the spillway does not take into account flow through the sluice gates.

The U.S. Army Corps of Engineers have performed a detailed hydrologic study on the Farmington River showing the maximum discharge from the Colebrook Dam to be 92,000 cfs.

SECTION 6 - STRUCTURAL STABILITY

6.1 Evaluation of Structural Stability

a. Visual Observations - During the course of the inspection, there were few items that were not functioning properly. A complete account of the visual inspection is contained in Section 3 and the post-construction changes are discussed in paragraph c below.

b. Design and Construction Data - The stability analysis of the embankment was accomplished for the entire dam against a headwater pressure and horizontal shear in upstream and downstream dam portions after complete drawdown (Appendix B, Page B-1, Reference 3). For the downstream fill of the dam, the shearing was defined with a varying height of seepage line. The properties of the dam fill was established on basis of the field tests (Reference 4, K. Terzghi's and L. Casagrande's reports) and from Merriman "American Civil Engineering Handbook", 1925. The computations were based on the methods used in "Engineering for Dams", 1947.

The computations showed that with all the combinations of loads for the accepted design configuration of the earth core, the factor of safety for all the combinations of the loads vary as follows:

1. For the entire dam, from 7.0 to 1.0 to 7.4 to 1.0,

2. For the downstream portion (Elevation 650) at point of maximum shear, 2.1 to 1.0 to 2.48 to 1.0,
3. For the upstream portion (100% drawdown from Elevation 650) at point of maximum shear, 1.55 to 1.0 to 2.5 to 1.0.
4. The accepted values for the factor of safety of the design were 7.0, 2.1 and 2.5 to 1.0, respectively. Dr. K. Terzaghi established an overall safety factor of 2.0 to 1.0 (Appendix B, Page B-1, Reference 4). These values of safety factors are higher than minimums suggested by the Corps of Engineers (Appendix B, Page B-1, Reference 8).

Evaluation of the stability computations for shearing of the embankment shows fairly conservative assumptions were used; for example, the minimum values of the mechanical properties of rock and earth were used, 100 percent drawdown was assumed and a considerable part of the downstream portion of the dam was assumed to be submerged.

An approximate calculation of the seepage stability of the dam core material was made by the study team using existing design data. A maximum hydraulic head of 94 feet (the difference between the upstream and downstream water

levels) and a thickness of the earth core at base of the dam of 107 feet, provides an hydraulic gradient of $(i) = 0.86$. This value is less than the value of the critical hydraulic gradient (i_c) for the impervious core, hence the relationship i/i_c is larger than the 1.5 minimum recommended in Appendix B, Page B-1, Reference 8.

A stability analysis of the concrete spillway weir against overturning and sliding was completed by the MDC for cases with varying combinations of cutoff, uplift, ice thrust, foundation anchoring systems and upstream and downstream water pressure. The computations show that the critical case is when the spillway weir does not have a cutoff and anchor bolts. In all other cases, the spillway weir has enough stability. The overturning safety factor varies from 1.12 to 1.0 to 29.2 to 1.0, the sliding safety factor varies from 0.14 to 1.0 to 0.87 to 1.0. The design of the spillway weir includes the cut-off and anchoring to the rock foundation.

c. Operating Records - For reasons of water rights, the Metropolitan District uses the following requirements for the discharge over or through this dam:

1. All natural stream flows up to 150 cfs.
2. Minimum 50 cfs at all times.
3. All releases by State from fishery pool. (The fishery pool releases cannot be counted as part of 50 cfs minimum in 2.)

4. Riparian releases as ordered by Riparian Owners.
(Not to exceed 400 mg in any one day nor at a rate greater than 800 mgd where 1 mgd = 1.54 cfs/day).
5. All releases from Otis Reservoir Watershed.

Section 5 discusses the adequate capacity of this spillway and establishes that the diversion channel is not necessary for the safety of the facility.

d. Post Construction Changes - Generally, the dam is in satisfactory condition. The following post construction changes have been noted:

1. Movements of the stone parapet walls at the junction of the gate house walls. The lateral movements were four inches (west end) and six inches (east end). The vertical settlements measured five inches and four inches, respectively. According to the inspection of October 10, 1973, the measurements were three inches and one inch, respectively.
2. Wetting, seepage and leaching of concrete along the horizontal construction joints of the interior walls of the gate house.
3. Considerable seepage from contraction joints and the vertical crack of the diversion channel in the zone near the gate house (the crack was formed

during the construction period. The total seepage discharge is approximately 6 to 7 gallons/minute. This seepage has evidence of leaching of lime from the concrete and rusting of reinforcement in concrete.

4. Corrosion of some metal items in the atmosphere exposed to high humidity and seepage; for example, the steel balcony in the diversion channel.
5. Minor spalling at the construction joints in the apron of the diversion channel.
6. Abutment cracks on the western end adjacent to the rollers at the northern and southern faces of the spillway channel bridge.

e. Seismic Stability - The dam is located in seismic zone number 1 and in accordance with Phase I guidelines does not warrant seismic analysis.

SECTION 7 - ASSESSMENT, RECOMMENDATIONS & REMEDIAL MEASURES

7.1 Dam Assessment

a. Condition - The geological, design and construction data, the results of the hydraulic model tests, the visual observations, the operating records, the post construction changes and the results of this inspection permits, the conclusion that the general condition of the dam and its appurtenant structures is good. The stability and reliability of the dam, its slopes and foundation is adequate and insures its operation for the design conditions.

b. Adequacy of Information - The assessment of the condition of the dam can be based on the information available as well as the visual inspection.

c. Urgency - The owner shall implement the recommendations and remedial measures described in the following sections within two to three years after receipt of this Phase I Inspection Report.

7.2 Recommendations

It is recommended that the following actions be undertaken by the owner:

1. Continue the ordinary inspections of the dam that have been started by the Metropolitan District with special attention to the vulnerable spots of

the dam, such as seepage from joints and cracks in the concrete of the gate house and diversion tunnel and the movements of the parapet walls on top of the dam in the area of the gate house.

2. Establish permanent monitoring of the behavior of the dam for the following observations:
 - (a). Movements of the parapet walls relative to the gate house. The frequency of the readings should be yearly.
 - (b). Seepage discharges through the dam in the zone of the diversion tunnel. The discharges should be measured in the two horizontal drains located at the outlet of the tunnel. The frequency of these readings is suggested monthly.
 - (c). Seepage discharges through the contraction joints and the vertical crack in the diversion tunnel from an area located near the downstream wall of the gate house. The frequency of these readings is suggested monthly.
 - (d). Temperature of seepage water so that additional information about the behavior of the structure can be formulated. The frequency of readings should be monthly.

Any of the above recommendations that require additional investigations should be done by a qualified engineering firm.

7.3 Remedial Measures

It is considered important that the following items be attended to as early as practical:

- a. Alternatives - Not applicable.
- b. O & M Maintenance and Procedures -
 1. Movement markers for monitoring of movements of the parapet walls relative to the gate house should be installed.
 2. Arrangements for metering of seepage discharges through the cracks, contraction joints and horizontal drains into concrete of the diversion tunnel should be commenced.
 3. Seepage cracks and joints into concrete of diversion tunnel should be repaired.
 4. Round-the-clock surveillance because of the location of the dam upstream of a populated area should be provided if spillway discharge from Colebrook Dam is anticipated or occurring. In addition, the owner should develop a formal system for warning downstream residents in case of an emergency.

APPENDIX A

VISUAL INSPECTION CHECK LIST

A-1 to A-8

VISUAL INSPECTION CHECK LIST
PARTY ORGANIZATION

PROJECT Goodwin Dam (Hogback)

DATE: 6-1-78

TIME

WEATHER Sunny

W.S. ELEV. 641.26 U.S. 534.00 N.S.

PARTY:

- | | |
|------------------------------|---------------------------------|
| 1. <u>Richard Lyon</u> | 6. <u>John Pozzato</u> |
| 2. <u>Miron Petrovsky</u> | 7. <u>Otis Matthews</u> |
| 3. <u>Gary Giroux</u> | 8. <u> </u> |
| 4. <u>John Schearer</u> | 9. <u> </u> |
| 5. <u>Peter Revill (MDC)</u> | 10. <u> </u> |

PROJECT FEATURE	INSPECTED BY	REMARKS
1. <u> </u>	<u> </u>	<u> </u>
2. <u> </u>	<u> </u>	<u> </u>
3. <u> </u>	<u> </u>	<u> </u>
4. <u> </u>	<u> </u>	<u> </u>
5. <u> </u>	<u> </u>	<u> </u>
6. <u> </u>	<u> </u>	<u> </u>
7. <u> </u>	<u> </u>	<u> </u>
8. <u> </u>	<u> </u>	<u> </u>
9. <u> </u>	<u> </u>	<u> </u>
10. <u> </u>	<u> </u>	<u> </u>

Air Temperature 75° F

Upstream Temperature 59° F

Downstream Temperature 40° F

PERIODIC INSPECTION CHECK LIST

PROJECT Goodwin Dam

DATE 6-1-78

PROJECT FEATURE _____

NAME R. Lyon

DISCIPLINE _____

NAME G. Giroux

AREA EVALUATED	CONDITIONS
<u>DAM EMBANKMENT</u>	
Crest Elevation	Excellent condition
Current Pool Elevation	Excellent condition
Maximum Impoundment to Date	Excellent condition
Surface Cracks	None observed
Pavement Condition	Good
Movement or Settlement of Crest	None observed
Lateral Movement	None observed
Vertical Alignment	None observed
Horizontal Alignment	Good alignment
Condition at Abutment and at Concrete Structures	Good condition at abutment
Indications of Movement of Structural Items on Slopes	Five inches of settlement at gate house
Trespassing on Slopes	None permitted
Sloughing or Erosion of Slopes or Abutments	None
Rock Slope Protection - Riprap Failures	No failures
Unusual Movement or Cracking at or near Toes	None
Unusual Embankment or Downstream Seepage	None
Piping or Boils	None
Foundation Drainage Features	None (Rounded on Rock)
Toe Drains	Foundation drains not found - underdrain

Instrumentation System

A.-2

None used

PERIODIC INSPECTION CHECK LIST	
PROJECT <u>Goodwin Dam</u>	DATE <u>6-1-78</u>
PROJECT FEATURE _____	NAME <u>M. Petrovsky</u>
DISCIPLINE _____	NAME <u>J. Schearer</u>
AREA EVALUATED	CONDITION
<p><u>OUTLET WORKS - INTAKE CHANNEL AND INTAKE STRUCTURE</u></p> <p>a. Approach Channel</p> <ul style="list-style-type: none"> Slope Conditions Bottom Conditions Rock Slides or Falls Log Boom Debris Condition of Concrete Lining Drains or Weep Holes <p>b. Intake Structure</p> <ul style="list-style-type: none"> Condition of Concrete Stop Logs and Slots 	<p>Underwater</p> <p>Excellent shape (steel slide gates)</p>

DATE 6-1-78

NAME M. Petrovsky

NAME J. Schearer

CONDITION

Underwater

Slope Conditions

Bottom Conditions

Rock Slides or Falls

Log Boom :

Debris

Condition of Concrete Lining

Drains or Weep Holes

Excellent shape (steel slide gates)

Condition of Concrete

Stop Logs and Slots

PERIODIC INSPECTION CHECK LIST

PROJECT Goodwin Dam

DATE 6-1-78

PROJECT FEATURE _____

NAME J. Pozzato

DISCIPLINE _____

NAME O. Matthews

AREA EVALUATED	CONDITION
<u>OUTLET WORKS - CONTROL TOWER</u>	
a. Concrete and Structural	
General Condition	Good
Condition of Joints	Good
Spalling	None
Visible Reinforcing	None
Rusting or Staining of Concrete	Some leaching spots in tower
Any Seepage or Efflorescence	Some at lower level
Joint Alignment	Good
Unusual Seepage or Leaks in Gate Chamber	Underwater
Cracks	Small hairline cracks in roof beams- studied by MDC
Rusting or Corrosion of Steel	Railing in stairwell corroded due to dampness
b. Mechanical and Electrical	
Air Vents	None
Float Wells	None
Crane Hoist	Electric bridge crane (under repair)
Elevator	None
Hydraulic System	None
Service Gates	Sluice gates
Emergency Gates	None
Lightning Protection System	None
Emergency Power System	Diesel- Good
Wiring and Lighting System in Gate Chamber	Good

PERIODIC INSPECTION CHECK LIST

PROJECT Goodwin Dam

DATE 6-1-78

PROJECT FEATURE _____

NAME M. Petrovsky

DISCIPLINE _____

NAME G. Giroux

AREA EVALUATED	CONDITION
<u>OUTLET WORKS - TRANSITION AND CONDUIT</u>	
General Condition of Concrete	Good
Rust or Staining on Concrete	Some observed at joints and hairline cracks
Spalling	None
Erosion or Cavitation	Slight amount of flow
Cracking	Some at gate house and between 1st and 2nd construction joints
Alignment of Monoliths	very good
Alignment of Joints	very good
Numbering of Monoliths	13

PERIODIC INSPECTION CHECK LIST

PROJECT Goodwin Dam

DATE 6-1-78

PROJECT FEATURE _____

NAME M Petrovsky

DISCIPLINE _____

NAME R. Lyon

AREA EVALUATED	CONDITION
<u>OUTLET WORKS - OUTLET STRUCTURE AND OUTLET CHANNEL</u>	
General Condition of Concrete	Granite Block - good condition
Rust or Staining	None
Spalling	None
Erosion or Cavitation	None
Visible Reinforcing	N/A
Any Seepage or Efflorescence	None
Condition at Joints	Good
Drain holes	None
Channel	Cut in rock (firm condition)
Loose Rock or Trees Overhanging Channel	None
Condition of Discharge Channel	Good - scour at gate
<p>Note: Riprap next to wingwall is washing out or slightly scoured.</p>	

PERIODIC INSPECTION CHECK LIST

PROJECT Goodwin Dam

DATE 6-1-78

PROJECT FEATURE _____

NAME M. Petrovsky

DISCIPLINE _____

NAME R. Lyon

AREA EVALUATED	CONDITION
<u>OUTLET WORKS - SPILLWAY WEIR, APPROACH AND DISCHARGE CHANNELS</u>	
a. Channel Ramp	
General Condition	Underwater
Loose Rock Overhanging Channel	N/A
Trees Overhanging Channel	N/A
Floor of Approach Channel	Underwater
b. Weir and Training Walls	
General Condition of Concrete	Good
Rust or Staining	None
Spalling	None
Any Visible Reinforcing	No
Any Seepage or Efflorescence	None observed (1" water flowing)
Drain Holes	None
c. Discharge Channel	
General Condition	Good
Loose Rock Overhanging Channel	Some observed in bottom of channel
Trees Overhanging Channel	None
Floor of Channel	Good (except loose rock)
Other Obstructions	None

PERIODIC INSPECTION CHECK LIST

PROJECT Goodwin Dam DATE 6-1-78
 PROJECT FEATURE _____ NAME R. Lyon
 DISCIPLINE _____ NAME G. Giroux

AREA EVALUATED	CONDITION
<u>OUTLET WORKS - SERVICE BRIDGE</u>	
a. Super Structure	
Bearings	Good
Anchor Bolts	N/A
Bridge Seat	Good
Longitudinal Members	Good
Under Side of Deck	Good
Secondary Bracing	N/A
Deck	Good
Drainage System	Good
Railings	Good
Expansion Joints	Sliding plates (good)
Paint	Concrete
b. Abutment & Piers	
General Condition of Concrete	Good
Alignment of Abutment	Good
Approach to Bridge	Good
Condition of Seat & Backwall	Good

APPENDIX B

LIST OF REFERENCES

B-1 to B-2

STAGE DISCHARGE CURVE

B-3

AREA CAPACITY CURVE

B-4

PAST INSPECTION REPORTS

B-5 to B-19

PLANS

GENERAL PLAN

Plate 1

SECTIONS AND DETAILS

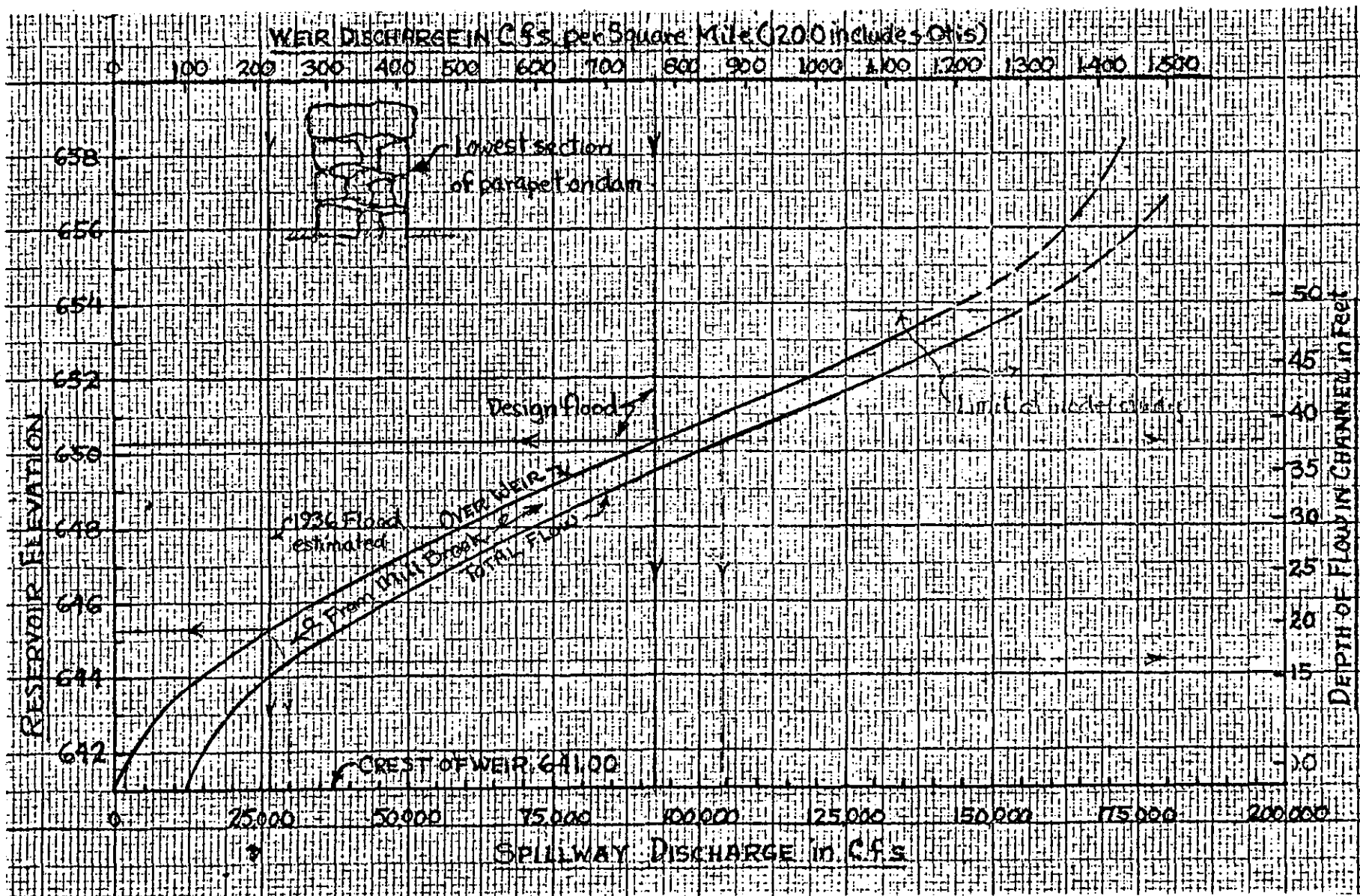
Plates 2, 3 & 4

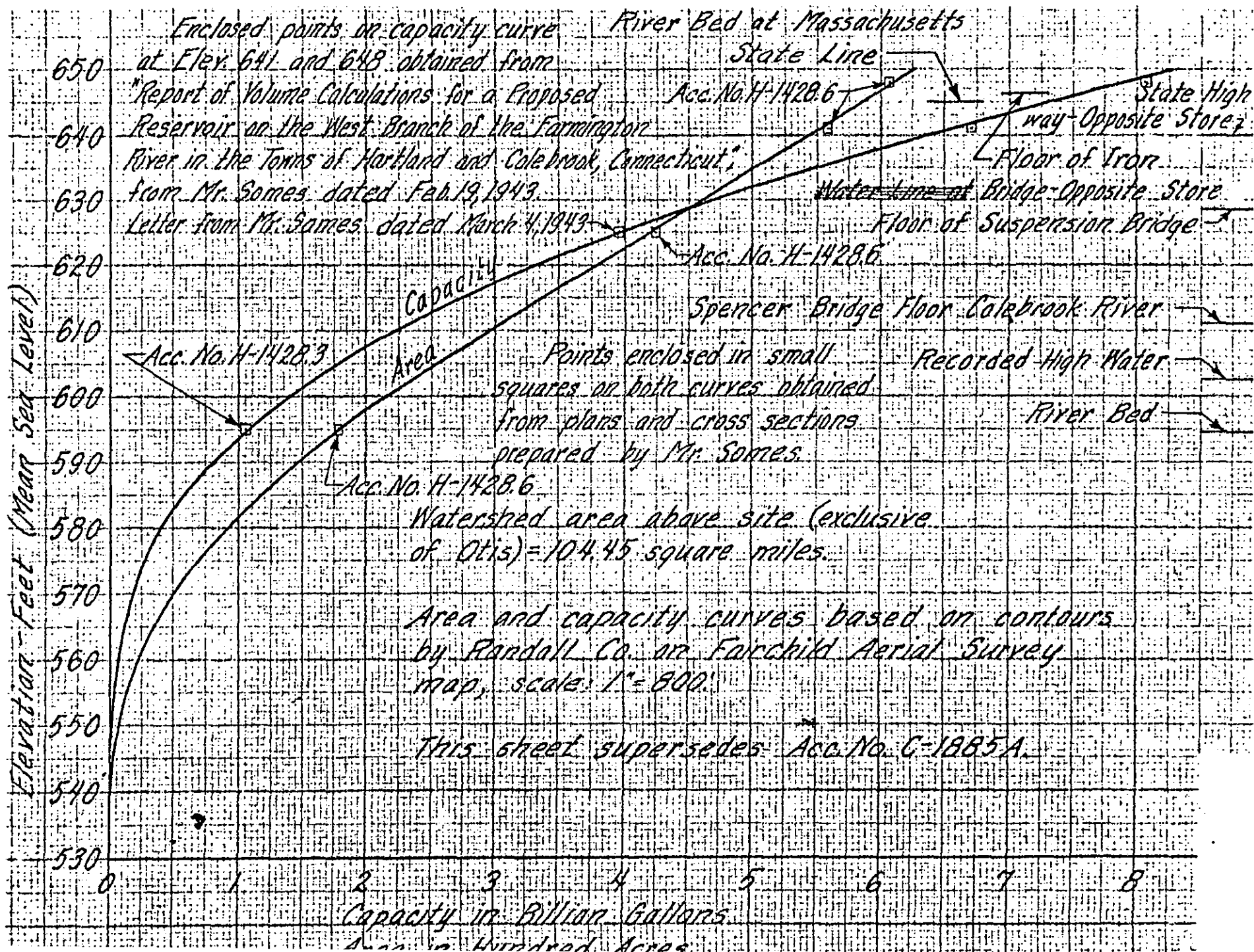
LIST OF REFERENCES

Reference numbers 1 through 7 are located at MDC Headquarters, 555 Main Street, Hartford, Connecticut.

1. "Construction of Hogback Dam". Contract 288. The Metropolitan District in Hartford, County, Connecticut; Water Bureau; 1955.
2. "Hogback Dam Model for Water Bureau". The Metropolitan District; Hartford 5, Connecticut; Alden Hydraulic Laboratory; Worcester Polytechnic Institute; January, 1954.
3. "Stability Analyses of Proposed Section and Spillway Weir of Hogback Dam". Contract 288. The Water Bureau of the Metropolitan District; Hartford County, Connecticut; 1952 to 1957.
4. Hogback Dam. Reports by Dr. K. Terzaghi, Professor F. E. Richart, Jr.; Professor S. D. Wilson and Dr. L. Casagrande. (Volume 1). Contract 288. The Metropolitan District; Hartford County, Connecticut; 1952 to 1954.
5. "Goodwin Dam Questionnaire for dams, outlets, high head gates and valves". Water Bureau; Metropolitan District; Hartford County, Connecticut.
6. Goodwin Dam - "Inspection of Dams and Spillways". Water Bureau. The Metropolitan District. Hartford County, Connecticut; Reference No. 2-1405; October 10, 1973; April 27, 1976; and May 4, 1976.
7. "Data on Safety of Metropolitan District Dams". Water Bureau. The Metropolitan District; Hartford County, Connecticut.
8. Recommended Guidelines for Safety Inspection of Dams. Department of the Army. Office of the Chief of Engineers; Washington, D.C.; November, 1976.
9. Guide Curves for the Probable Maximum Flood (PMF) for Regions of New England based on past Corps Studies, March, 1978.

10. Preliminary Guidance for Estimating Maximum Probable Discharges in Phase I Dam Safety Investigations; New England Division, Corps of Engineers; March, 1978.
11. Rule of Thumb. Guidance for estimating downstream dam failure hydrographs. Corps of Engineers; April, 1978.
12. "Instrumentation of Earth and Rockfill Dams". EM 110-2-1908, 31 August 1971; Department of the Army, Corps of Engineers.





INSPECTION OF DAMS AND SPILLWAYS

NAME OF DAM Goodwin Dam

LOCATION (Town, River, Reservoir) Hartland

INSPECTORS

Name

Title

Div./Dept.

Dick Allen

Asst. Engineer

S & P

Dick Conopask

Sr. Engineer

Design

In filling out this form, please enter full information on conditions, and on location of any defects.

A. GENERAL

- 1) Were any photographs taken of the dam during this inspection Yes
- 2) Reservoir level, Elev. 619.60
- 3) Weather (including comment on humidity) Cool, clear, sunny, dry (beautiful fall day - excellent foliage).

B. EARTH DAMS

- 1) Note any depressions in crest None
- 2) Slides and/or erosion, upstream face None
- 3) Slides and/or erosion, downstream face None
- 4) Cracks in embankment None

- 5) Surfacing on crest and condition Penetration macadam - excellent.
- 6) Condition of parapet walls, if any Excellent
- 7) Seepage on downstream face, especially at toe, (location and quantity)
None
- 8) Soft ground at toe (locate) None
- 9) Signs of settlement at gate house and/or gate house bridge Parapet settled;
W/S - 3" @ G.H.; Parapet E/S-1" @ G.H. See Pictures #2 and #3.
- 10) *Downstream drainage system (clear or blocked, etc.) Clear - stone paved
ditches on berms should be de-grassed.
- 11) Type and condition of downstream face planting grass-good.
- 12) Is planting and/or debris etc. a fire hazard? No
- 13) Do plantings obscure toe of dam and other points where monitoring inspection is necessary? No, exceptionally clear - See Picture #1
- 14) Damage or vandalism (to lights, plaques, etc.) door knobs damaged; dents
from thrown rocks in G.H. door; U.S. flag stolen periodically.
- 15) Other Intrusion alarm in G.H. intentionally activated frequently by
vandals.

C. CONCRETE DAMS

- 1) Any signs of motion _____

* Drain pipe outfalls @ toe of dam should continue to be de-brushed.
Small culvert on access road on west downstream side of dam needs cleaning.

2) Deterioration noted:

Upstream face _____
Downstream face _____
Road/walk on crest _____
Parapets _____
Spillway _____
Other (excluding gate houses) _____

3) Inspection Gallery:

General condition _____
Leakage _____
Lime accumulation _____
Flooding & drainage _____
Other, _____

4) Damage or vandalism (to lights, plaques, etc.) _____

5) Other comments _____

D. GATE HOUSES

i) Upper House

1) Exterior: walls Excellent - See Pictures #4 and #5.
windows Good - 2 lights middle window west side broken.
doors Gen. Good - slight weathering problem.
roof Excellent - new roof in 1972.

2) Superstructure Interior:

walls Excellent - See Picture #6.

floor Excellent

ceiling Good - Cracks in ceiling beams - See Picture #7

3) Leakage into superstructure None

4) Substructure, interior:

Leakage and condensation both moderate

Condition of metal work (stairs, etc.) Good in upper
chamber - lower metal work is rusty - See Pictures #8, 9
and 10.

5) Equipment condition:

Sluice gates OK

Gate valves OK

Piping -

Electrical gear OK

Other Diesel OK

6) Do all electric lights work Yes

7) Condition of stop logs in storage well Good - those stored at lower elev.
are getting rusty.

8) Operating personnel comments on functional condition of all equipment
(valves, hoists, selector gates, trash racks, screens, etc.) _____
Generally excellent - west rail on trolley, section of rail is warped causing
wire pull out (motor feed) when operated - should be replaced.

- 9) Last time various wells and other underwater portions were unwatered and examined (Give name of well and date in case of multiple wells).

- 10) Other comments Dehumidification and/or heating recommended in stairwell.
See Pictures #8 and #9.

ii) Lower House

- 1) Exterior: walls _____
windows _____
doors _____
roof _____

- 2) Superstructure Interior:
walls _____
floor _____
ceiling _____

- 3) Leakage into superstructure _____

- 4) Substructure, interior:
Leakage and condensation _____

Condition of metal work (stairs, etc.) _____

- 5) Equipment condition:
Sluice gates _____
Gate valves _____
Piping _____

Electrical gear _____

Other _____

- 6) Do all electric lights work _____
- 7) Condition of stop logs in storage well _____
- 8) Operating personnel comments on functional condition of all equipment
(valves, hoists, selector gates, trash racks, screens, etc.) _____

9) Other comments _____

iii) Conduit between gate houses Stream flow tunnel - See Picture #16.

- 1) Concrete condition Good
- 2) Leakage Moderate - @ 1st & 2nd constr. joints in roof.
- 3) Condition of metal work and piping Piping not inspectable w/flow
Balcony - Poor, very rusty.
- 4) Other comments Balcony supports should be inspected in detail w/no flow -
Recommend repalcing steel balcony w/aluminum or stainless steel balcony-
See Picture #10.

E. PRINCIPLE SPILLWAY

(If spillway is part of dam, enter information in C only).

- 1) Weir Excellent, minor spalling at constr. joints in apron.

- 2) Channel Excellent - side slopes stable,
- 3) Outlet of channel _____
- 4) Note any obstructions to flow Minor rock falls immediately no. & so. of bridge
- 5) Bridge Excellent - abutment cracks on west end adjacent to rollers (both north and south faces) see pictures #11 and #12.
- 6) Is water spilling No
- 7) Other comments Recommend installation of 6' fence along east side of spillway channel from bridge to natural stream bed of Mills Brook; also from bridge downstream to end of channel on east side. See Picture #13. Also recommend some type of barrier to prevent easy access to spillway weir from parapet wall, See Picture #14.

F. EMERGENCY SPILLWAY

- 1) Channel _____
- 2) Obstructions _____
- 3) Other comments _____

G. APPURTENANT STRUCTURES

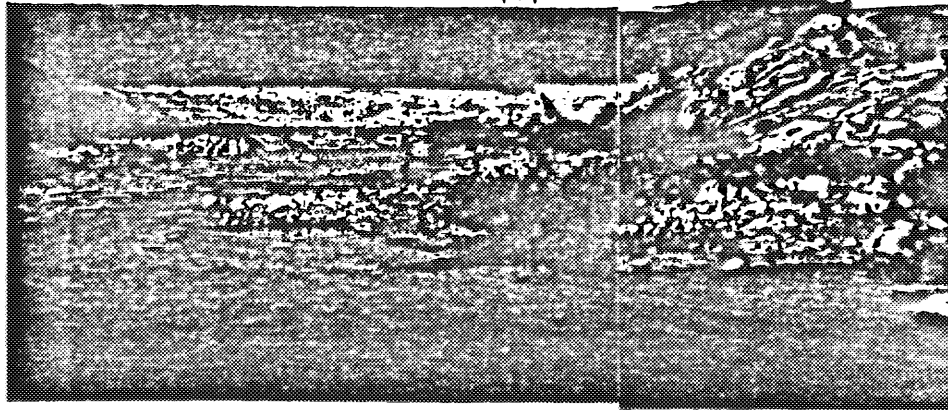
List structure (such as stilling pools, discharge weir structures, stream diversion works, etc. and give conditions.

Mills (Thorn) brook channel - excellent, side slopes stable.

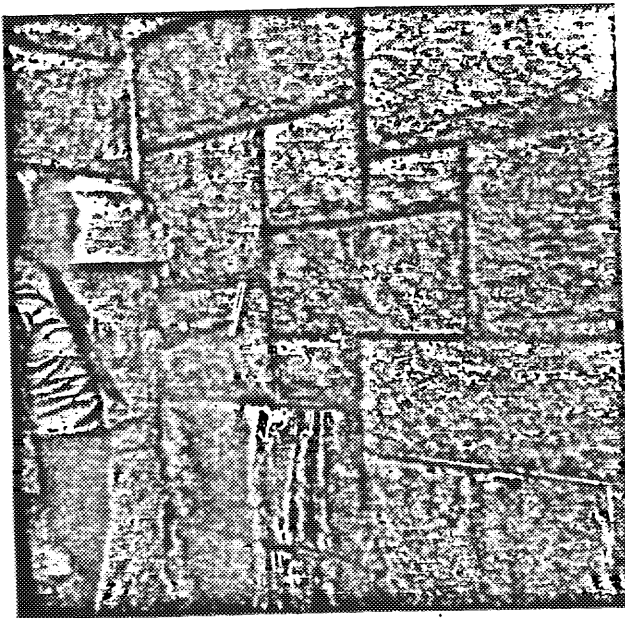
H. OVERALL ASSESSMENTS

Is this dam with its appurtenances maintained in a condition satisfactorily to the Inspectors? Excellent, lack of recreation population loading eases exterior maintenance requirements.

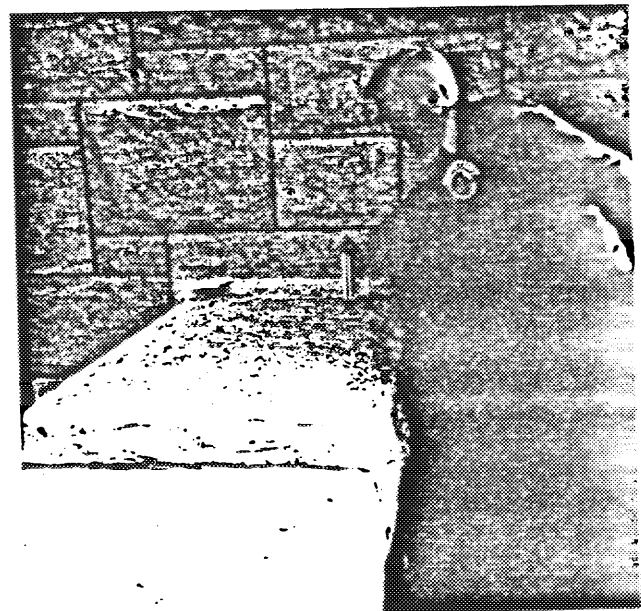
GOODWIN DAM



#1. Showing good conditions on downstream face and toe of slope.

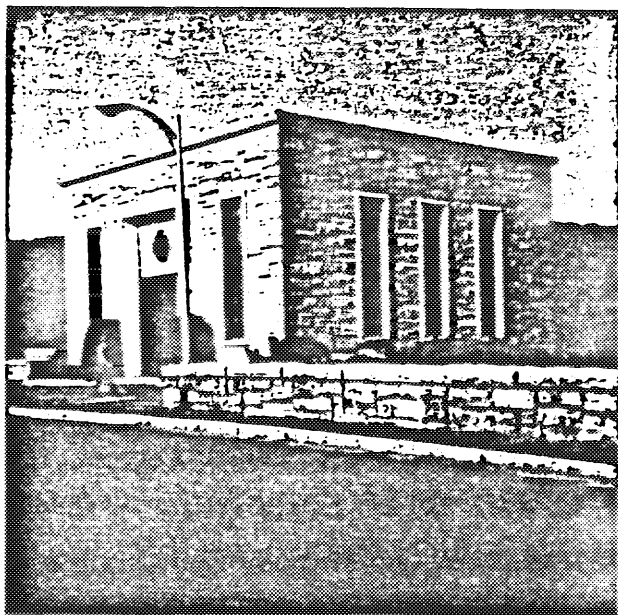


#2. Parapet wall settlement at west side of upper Gate House.

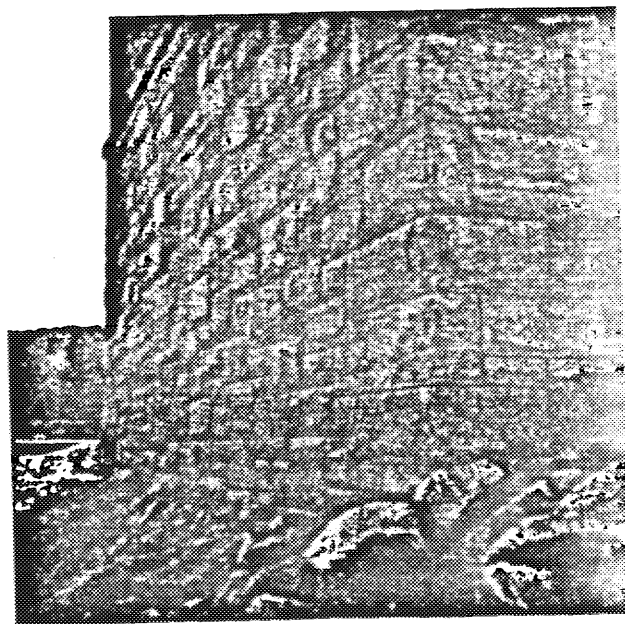


#3. Parapet wall settling has caused some minor joint separation on upstream side adjacent to Upper Gate House.

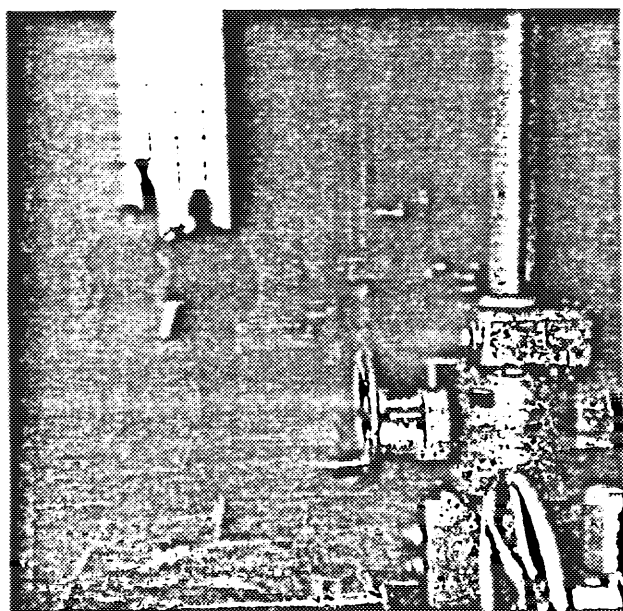
GOODWIN DAM



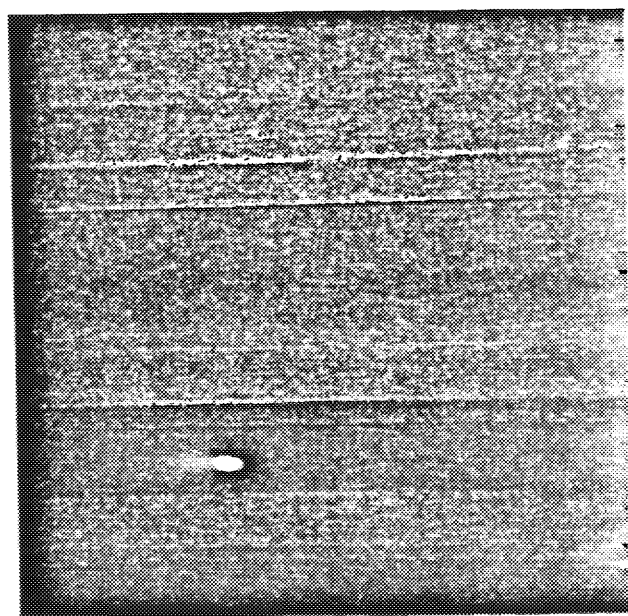
#4. Upper Gate House is in excellent condition.



#5. Upstream face of Upper Gate House shows no ice damage.

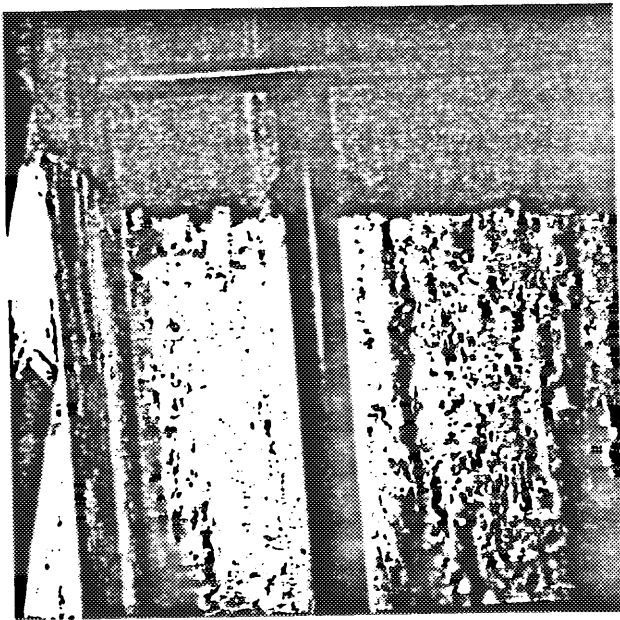


#6. Excellent conditions on Upper Gate House interior.

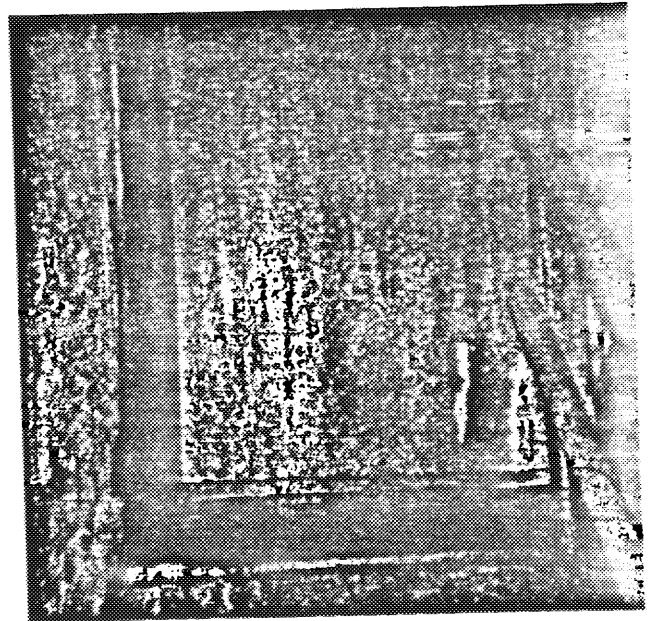


#7. Ceiling beams in Upper Gate House are cracked near center. Should continue to be monitored.

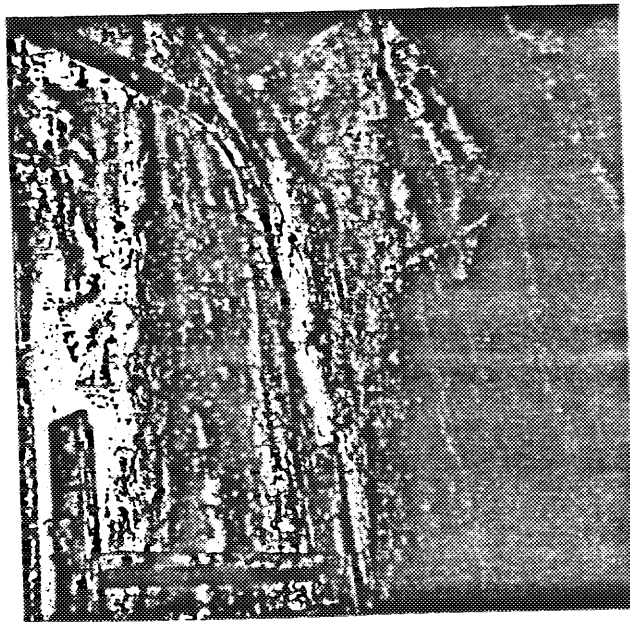
GOODWIN DAM



#8. Lime leaching at first joint below water line.

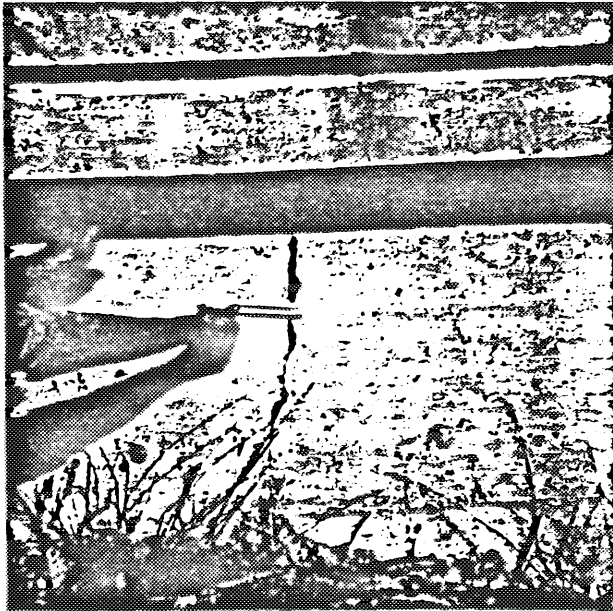


#9. Generally wet below water line.

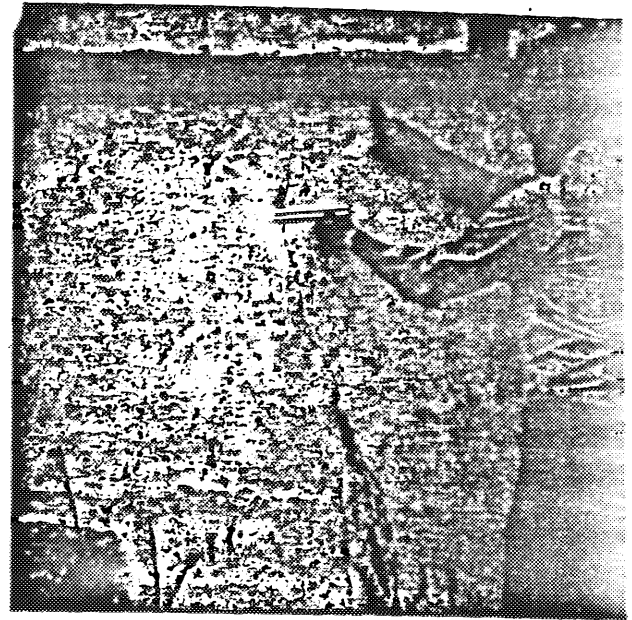


#10. Poor conditions in stream flow tunnel.

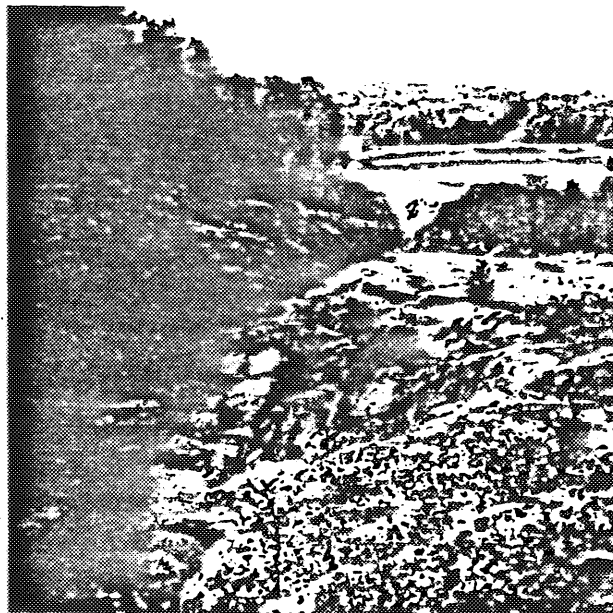
GOODWIN DAM



#11. South face at West end. Finger points to location of rollers.

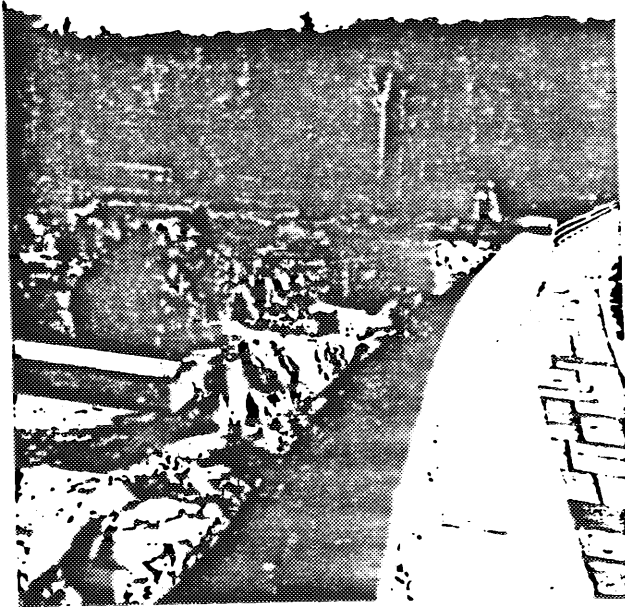


#12. North face at West end. Finger points to location of rollers.

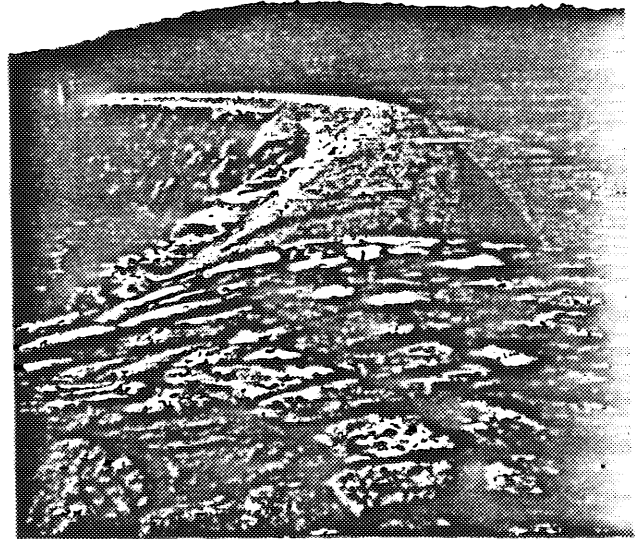


#13. Rock cut on east side of spillway channel is presently accessible from woods and is a potential hazard to casual wanderers.

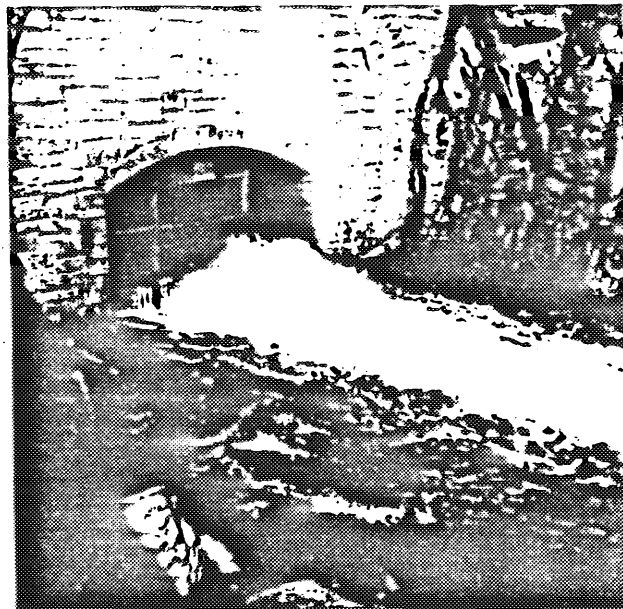
GOODWIN DAM



#14. There is presently no effective barrier to upstream west side of spillway channel.



#15. This area is directly accessible from point indicated in picture #14.



#16. Outlet of stream flow tunnel passing 230 cfs.

INSPECTION OF WATER BUREAU FACILITIES

SYSTEM Supply FACILITY Dam

NAME OF FACILITY Goodwin Dam

LOCATION W. Pr. Farmington R.

Tunnel well & Lower inlet well

INSPECTORS:	NAME	TITLE	DIVISION/DEPT.
	<u>P.J. Revill</u>	<u>Ch. Des. Engr.</u>	<u>Designing</u>
	<u></u>	<u></u>	<u></u>
	<u></u>	<u></u>	<u></u>

CONDITION OF FACILITY:

Tunnel well & tunnel heading entered, lower inlet well only seen from floor & 6'x6' sl. gate.

Concrete Note a lot of lime deposits on walls of tun. well below lower constr. joints. Also lime on roof of part of tunnel transition. Tunnel entered 150'± only. Usual transverse cracks & lime "drippings". Much debris on floor - gravels, misc. materials. Floor probably sound, but water too deep to determine. Very little seepage.

Metalwork. In tunnel well - excellent. In lower inlet well what could be seen - good/excellent.

WORK SUGGESTED BY OPERATING AUTHORITY:

None

RECOMMENDATIONS:

No work necessary.
Inspect in 1981.

INSPECTION OF WATER BUREAU FACILITIES

SYSTEM Supply FACILITY Dam

NAME OF FACILITY Goodwin Dam

LOCATION River flow wells & outlet conduit

INSPECTORS:

NAME

TITLE

DIVISION/DEPT.

L. E. Kirk

Sr. Eng.

Construction

P. J. Revill

Ch. Des. Eng.

Designing

CONDITION OF FACILITY:

Intake & Etw river flow wells & connecting waterway inspected only from invert. Wells viewed by floodlight but not climbed or travelled. General condition: excellent. A little concrete erosion at invert of inlet well, 3"± deep - not serious. Metalwork all seems sound & reasonably free of rust or tuberculations. Inlet well ladder has lost bolts at 2 lower wall brackets, has no floor bolts. Screen cage over 6" slgt. in West well missing. Stainless steel bolts in outlet increasers in conduit intact.

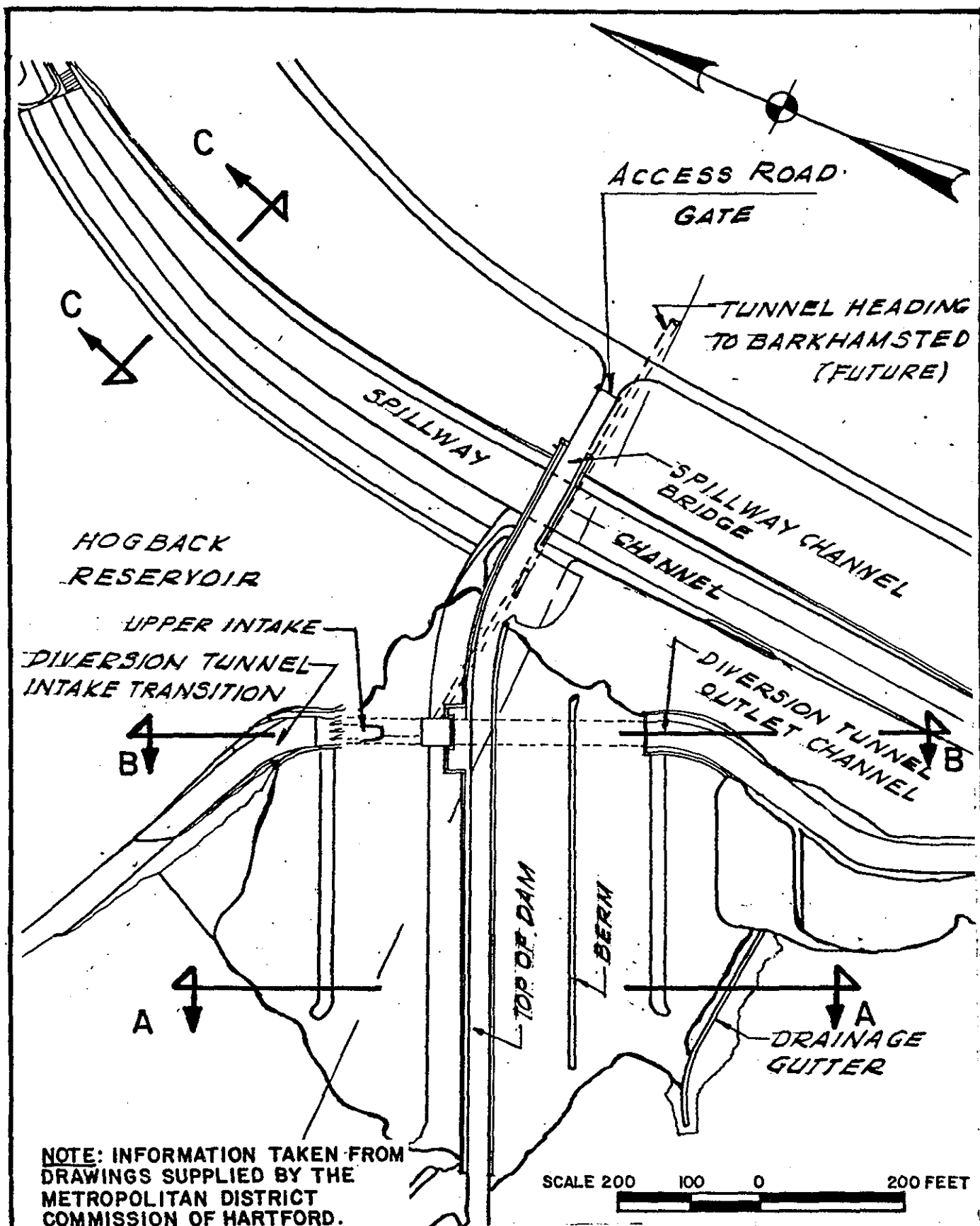
Outlet conduit - fair, has some leaks; floor erosion not more than

WORK SUGGESTED BY OPERATING AUTHORITY: Seen years before. West drain over block next to end wall gate has heavily rust coloured water.

RECOMMENDATIONS:

Repair ladder in inlet well with stainless steel nuts, bolts washers. Reinspect in 1981.

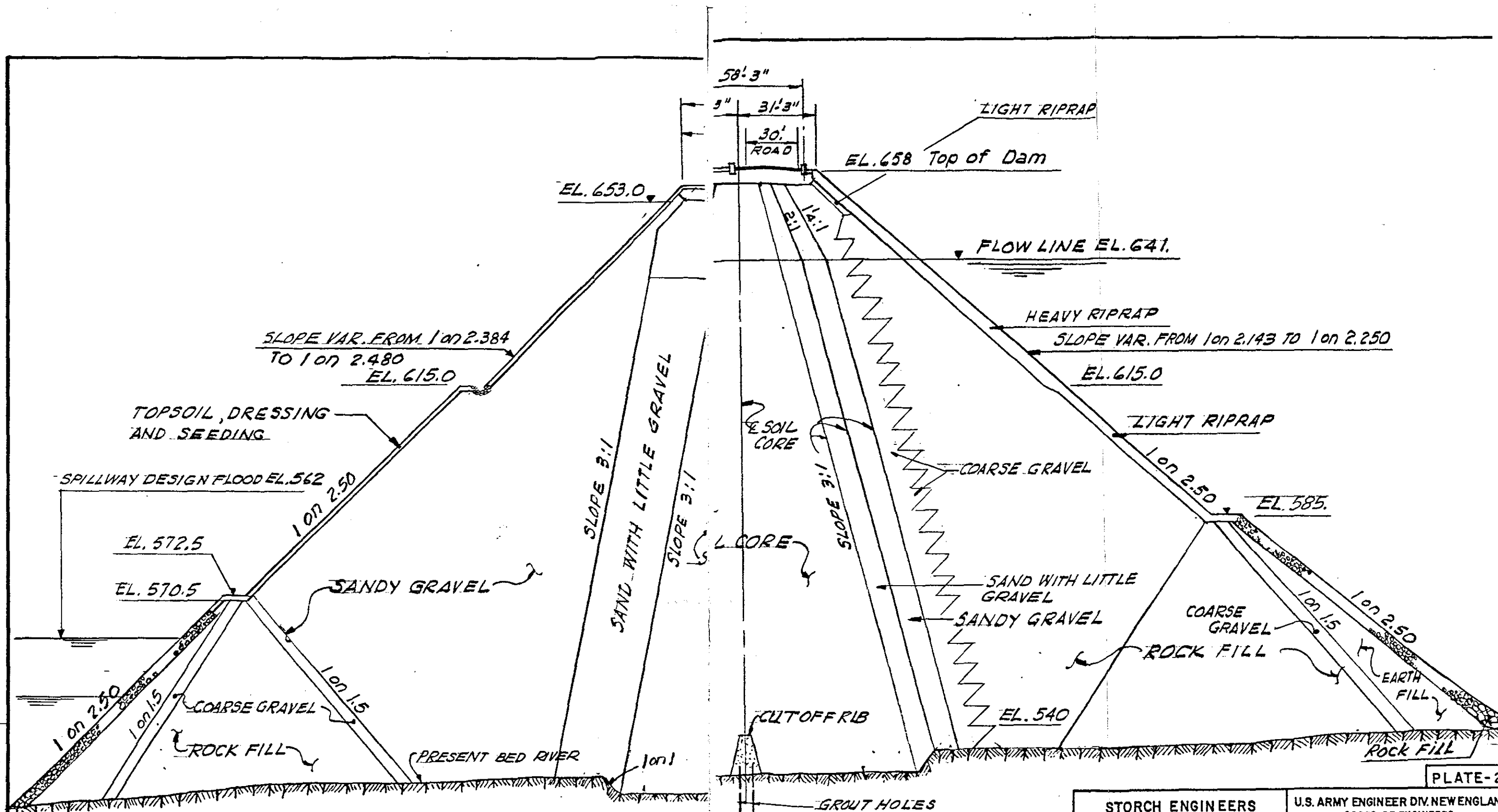
Photos taken, See over.



U.S. ARMY, CORPS OF ENGINEERS
 NEW ENGLAND DIVISION
 WALTHAM, MASS.

GOODWIN DAM
 GENERAL PLAN

PLATE-I

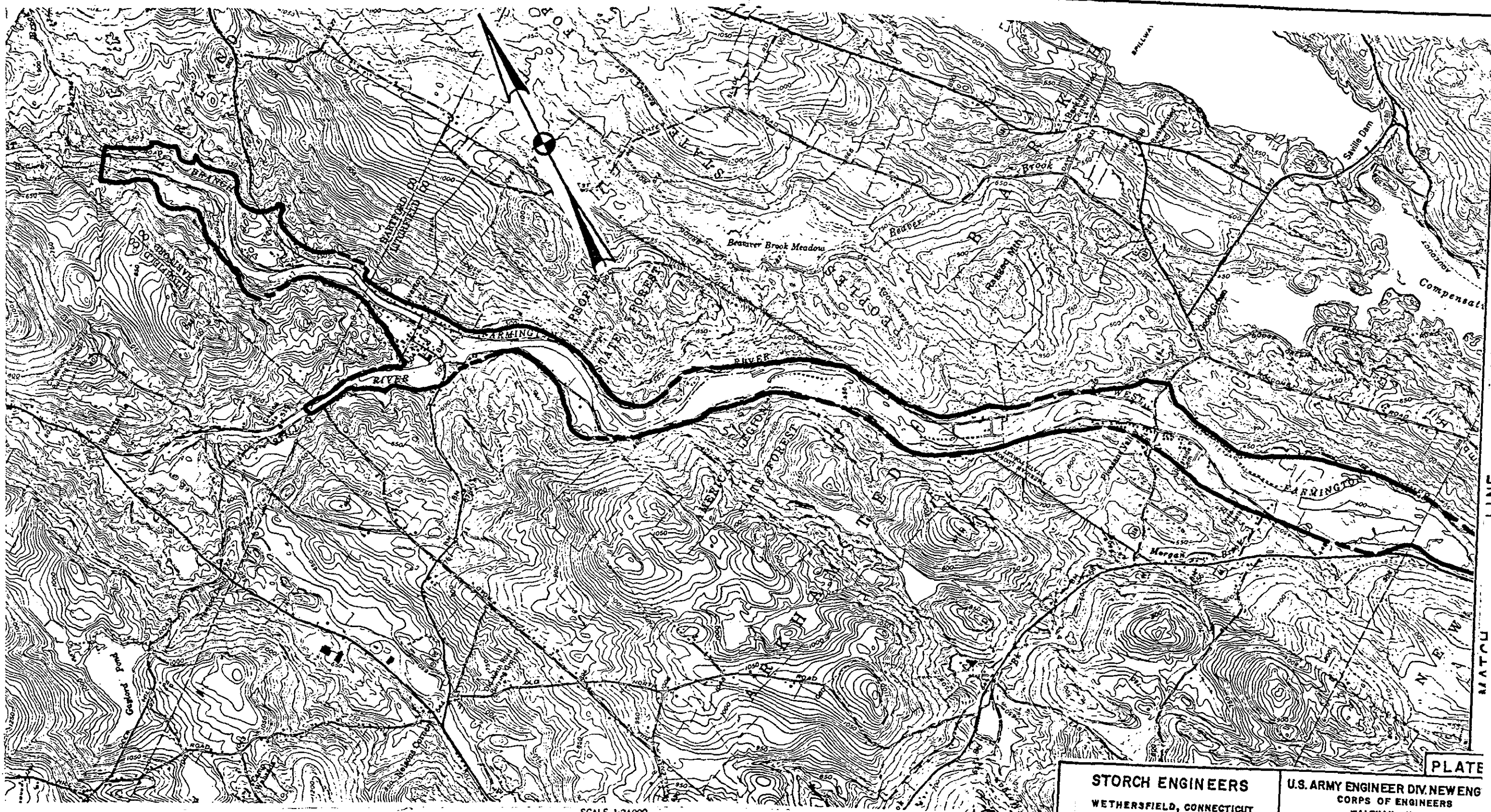


SECTION A-A to Scale

NOTE: INFORMATION TAKEN FROM DRAWINGS SUPPLIED BY THE METROPOLITAN DISTRICT COMMISSION OF HARTFORD.

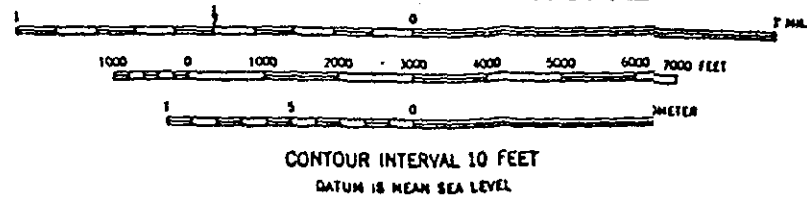
STORCH ENGINEERS WETHERSFIELD, CONNECTICUT		U.S. ARMY ENGINEER DIV. NEW ENGLAND CORPS OF ENGINEERS WALTHAM, MASS.	
NATIONAL PROGRAM OF INSPECTION OF NON-FED. DAMS			
GOODWIN DAM			
FARMINGTON RIVER		CONNECTICUT	
		SCALE: AS SHOWN	
		DATE : SEPTEMBER - 1978	

PLATE-2



LEGEND

--- DENOTES LIMITS OF FLOODING
IN CASE OF DAM FAILURE



STORCH ENGINEERS
WETHERSFIELD, CONNECTICUT

U.S. ARMY ENGINEER DIV. NEW ENGLAND
CORPS OF ENGINEERS
WALTHAM, MASS.

NATIONAL PROGRAM OF INSPECTION OF NON-FED. DAM

GOODWIN DAM

FARMINGTON RIVER

CONNECTICUT

SCALE: AS SHOWN

DATE: SEPTEMBER - 1978

PLATE - 6

LINE

MATCH

PLATE - 8

LINE

MATCH

PLATE - 7

STORCH ENGINEERS
WETHERSFIELD, CONNECTICUT

U.S. ARMY ENGINEER DIV. NEW ENGLAND
CORPS OF ENGINEERS
WALTHAM, MASS.

NATIONAL PROGRAM OF INSPECTION OF NON-FED. DAMS

GOODWIN DAM

FARMINGTON RIVER

CONNECTICUT

SCALE: AS SHOWN

DATE: SEPTEMBER - 1978

LEGEND

--- DENOTES LIMITS OF FLOODING
IN CASE OF DAM FAILURE

SCALE 1:24,000

1000 0 1000 2000 3000 4000 5000 6000 7000 FEET

1 0 1 KILOMETER

CONTOUR INTERVAL 10 FEET
DATUM IS MEAN SEA LEVEL

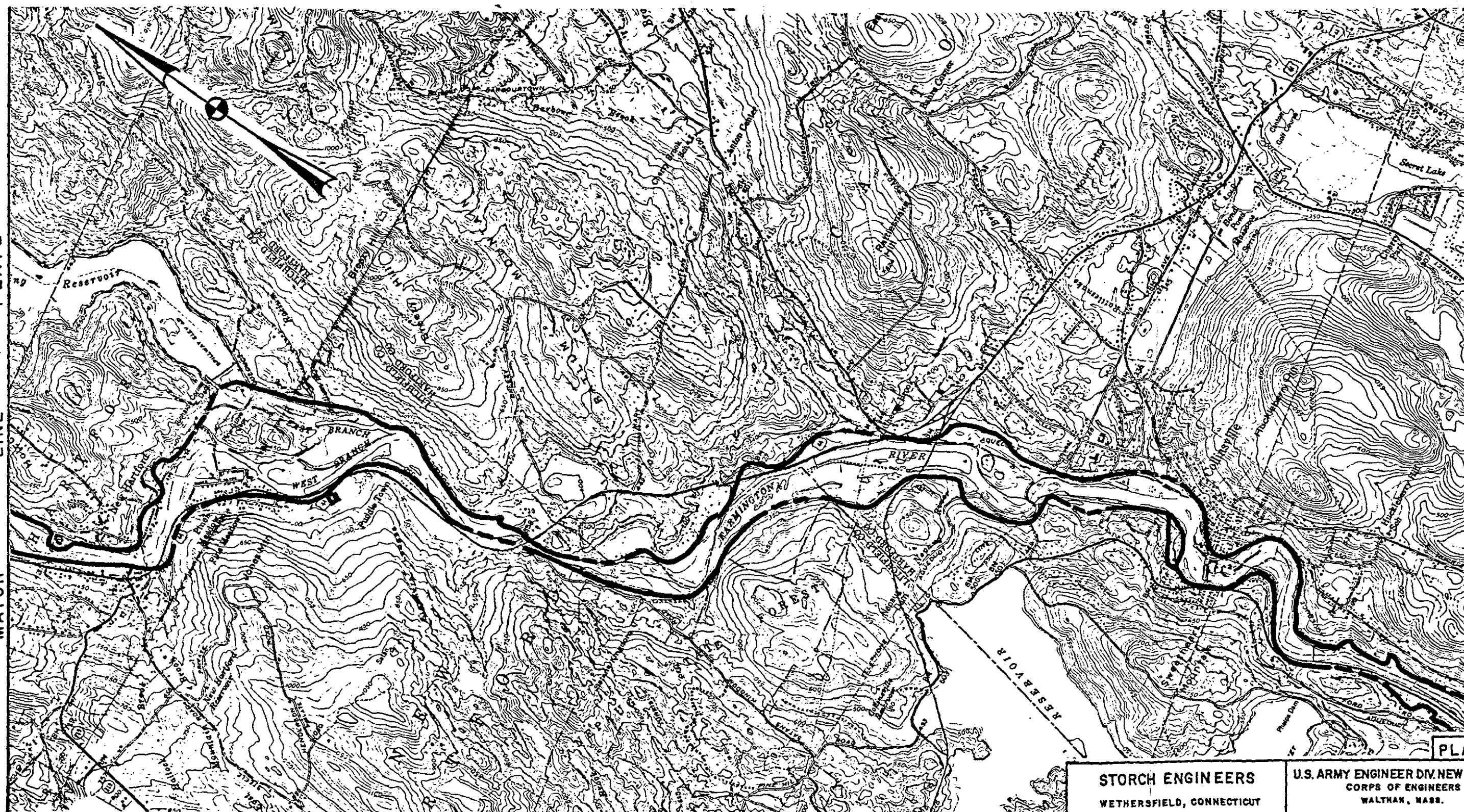
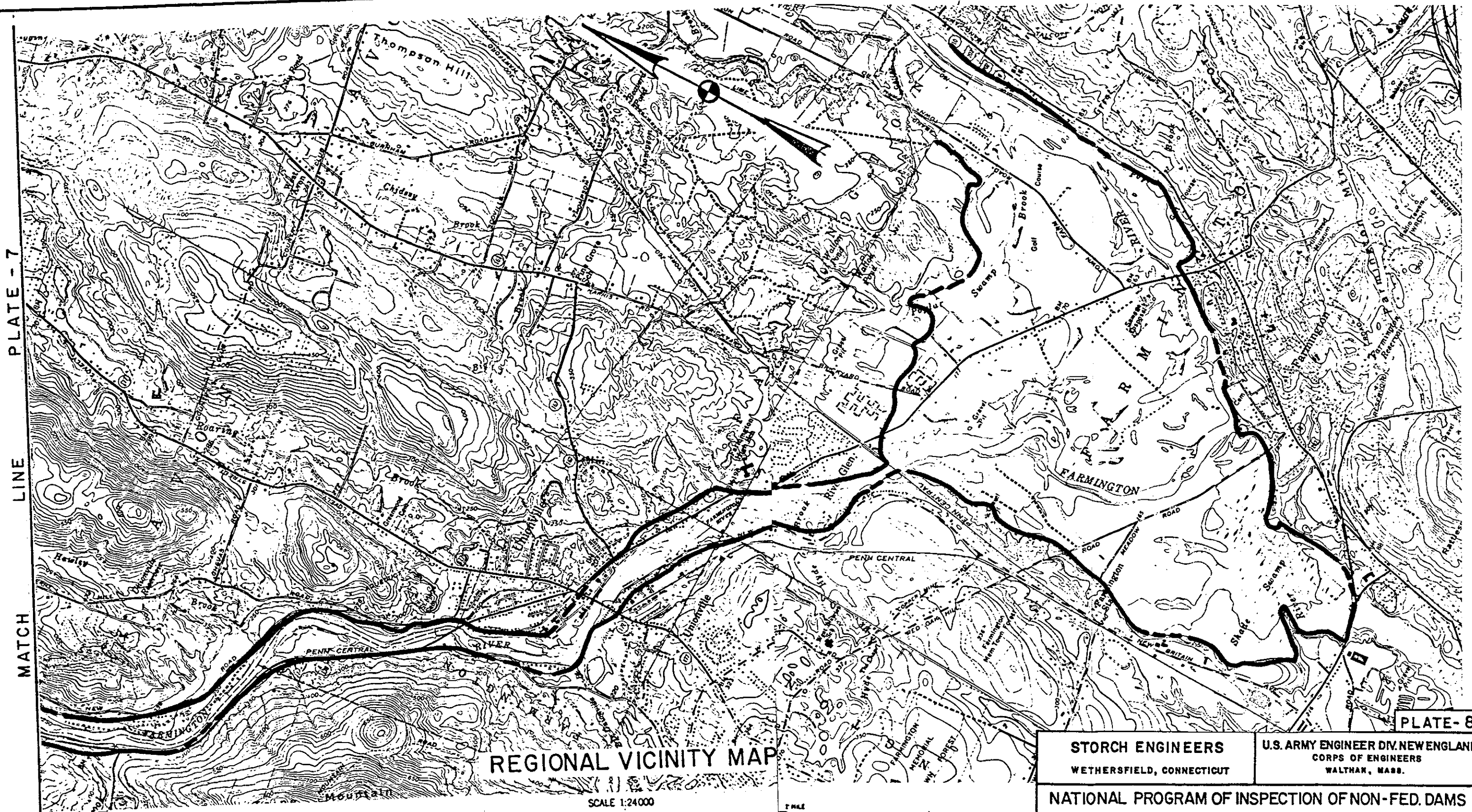


PLATE - 7

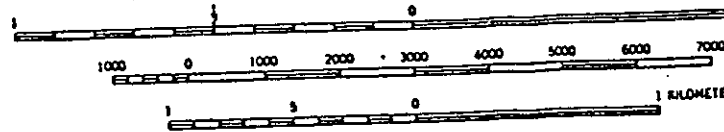
LINE

MATCH



REGIONAL VICINITY MAP

SCALE 1:24000



CONTOUR INTERVAL 10 FEET
DATUM IS MEAN SEA LEVEL

LEGEND

--- DENOTES LIMITS OF FLOODING
IN CASE OF DAM FAILURE

PLATE - 8

STORCH ENGINEERS
WETHERSFIELD, CONNECTICUT

U.S. ARMY ENGINEER DIV. NEW ENGLAND
CORPS OF ENGINEERS
WALTHAM, MASS.

NATIONAL PROGRAM OF INSPECTION OF NON-FED. DAMS

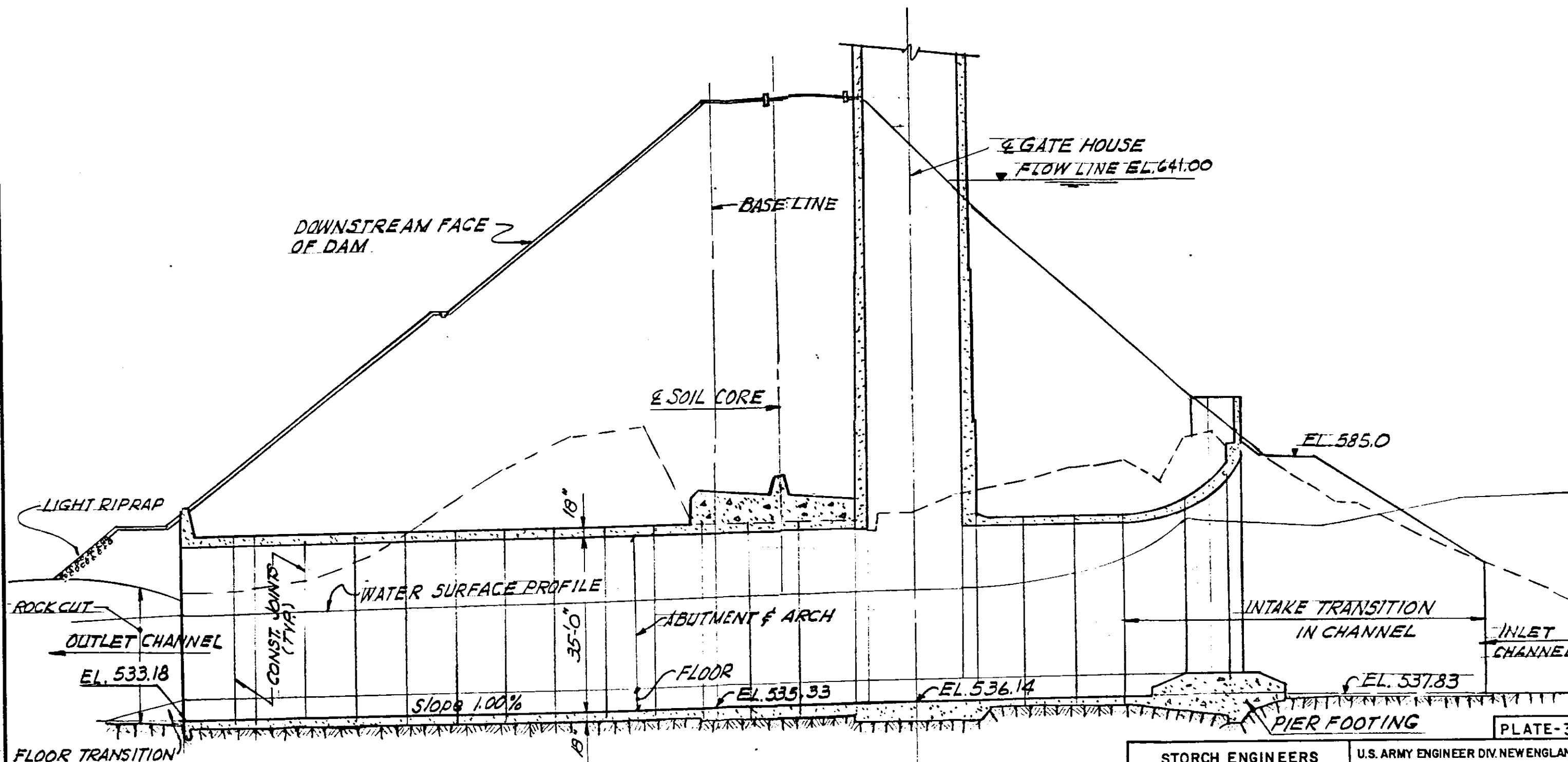
GOODWIN DAM

FARMINGTON RIVER

CONNECTICUT

SCALE: AS SHOWN

DATE: SEPTEMBER - 1978



SECTION B-B

Not to Scale

NOTE: INFORMATION TAKEN FROM
DRAWINGS SUPPLIED BY THE
METROPOLITAN DISTRICT
COMMISSION OF HARTFORD.

STORCH ENGINEERS
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U.S. ARMY ENGINEER DIV. NEW ENGLAND
CORPS OF ENGINEERS
WALTHAM, MASS.

NATIONAL PROGRAM OF INSPECTION OF NON-FED. DAMS

GOODWIN DAM

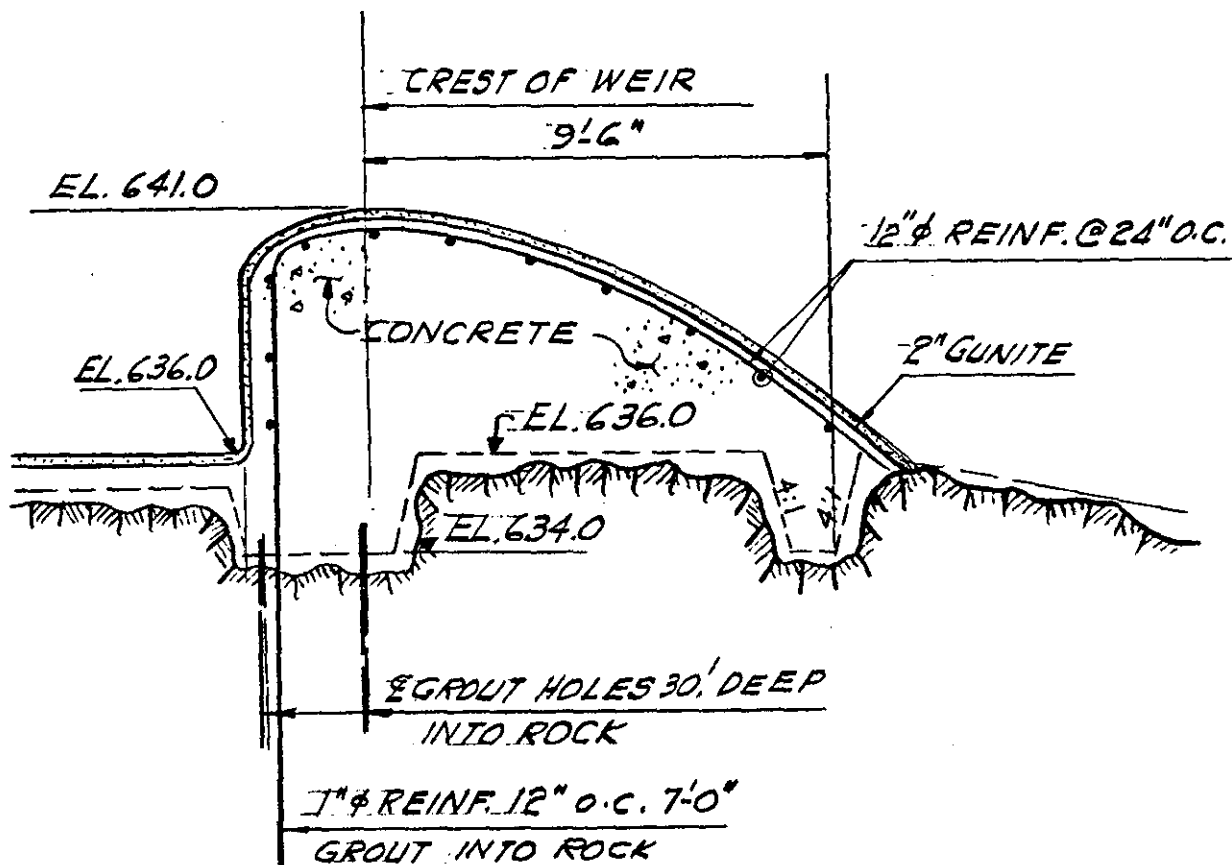
FARMINGTON RIVER

CONNECTICUT

SCALE: AS SHOWN

DATE: SEPTEMBER-1978

PLATE-3



SECTION C-C

Not to Scale

NOTE: INFORMATION TAKEN FROM
DRAWINGS SUPPLIED BY THE
METROPOLITAN DISTRICT
COMMISSION OF HARTFORD.

U.S. ARMY, CORPS OF ENGINEERS
NEW ENGLAND DIVISION
WALTHAM, MASS.

GOODWIN DAM
SECTION AND DETAILS

PLATE - 4

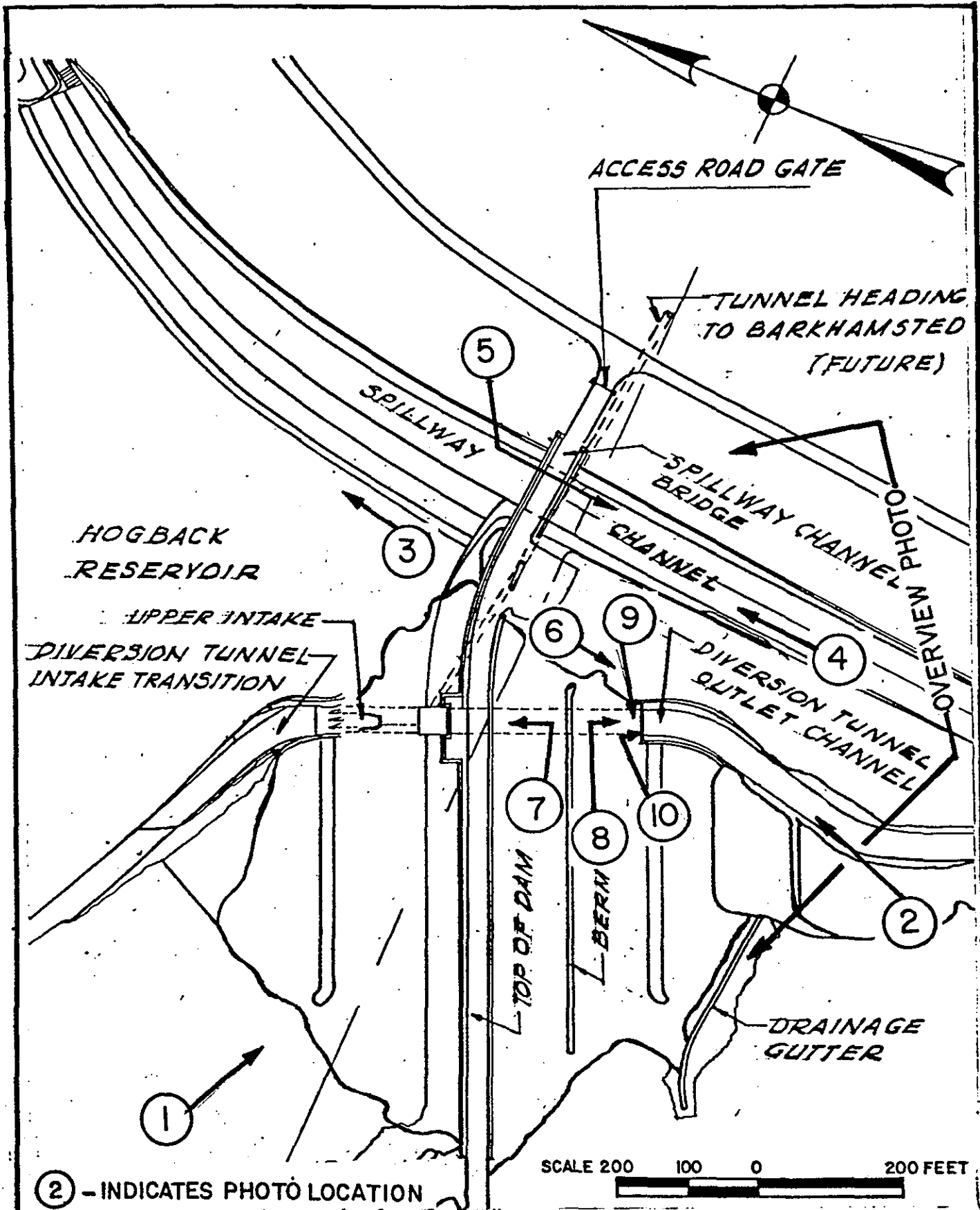
APPENDIX C

PHOTO LOCATION PLAN

Plate 5

PHOTOGRAPHS

II-1 to II-5



U.S.ARMY, CORPS OF ENGINEERS
 NEW ENGLAND DIVISION
 WALTHAM, MASS.

GOODWIN DAM
 PHOTO LOCATION PLAN

PLATE 5



PHOTO 1
UPSTREAM FACE OF DAM AND GATE HOUSE

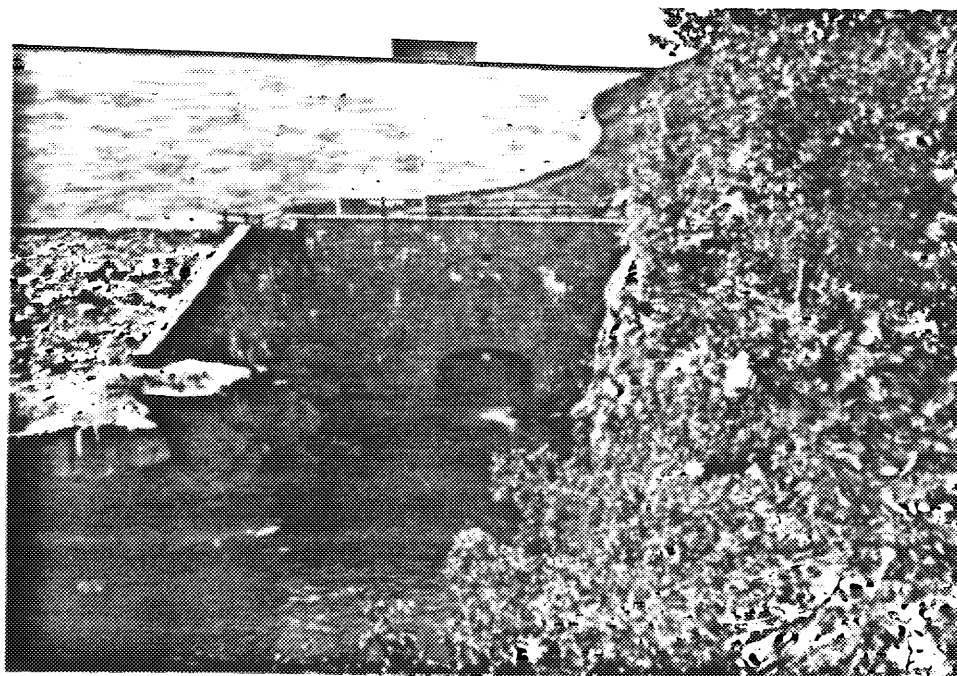


PHOTO 2
DIVERSION TUNNEL - OUTLET

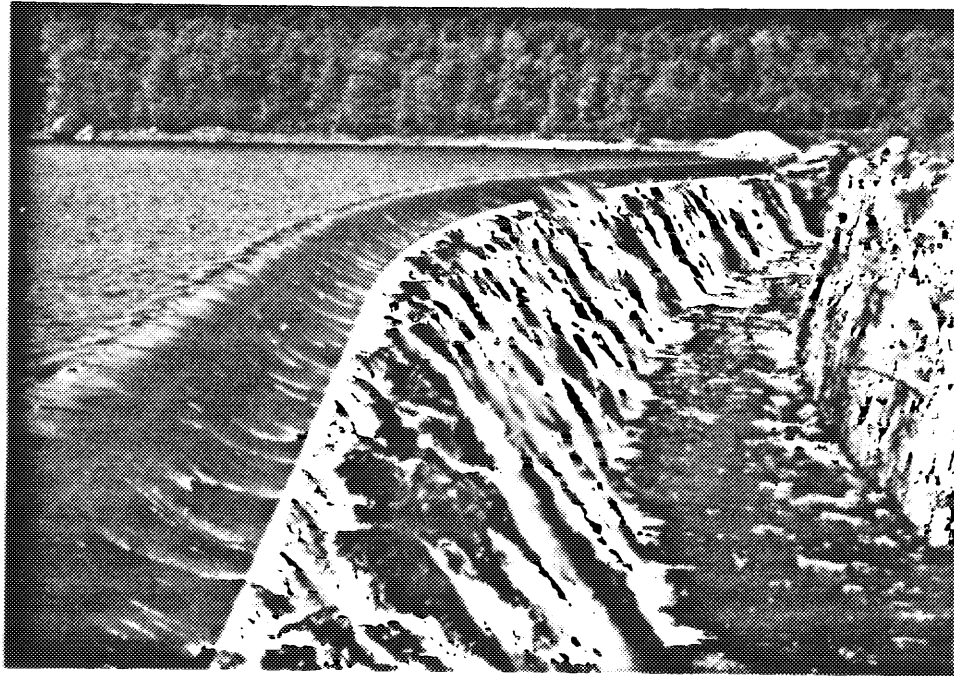


PHOTO 3
SPILLWAY WEIR

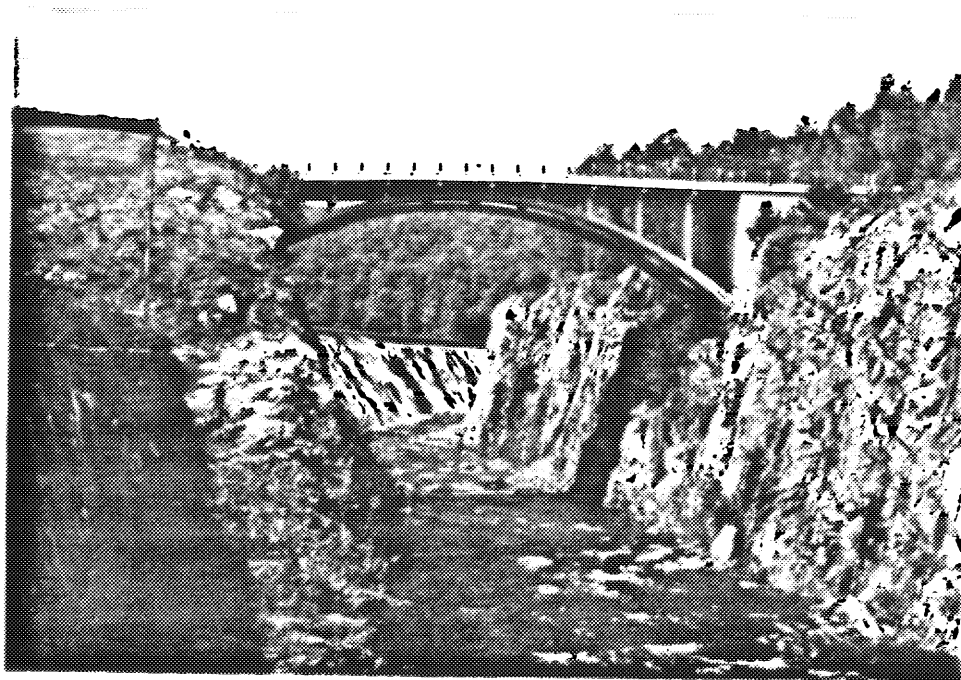


PHOTO 4
SPILLWAY CHANNEL AND SERVICE BRIDGE

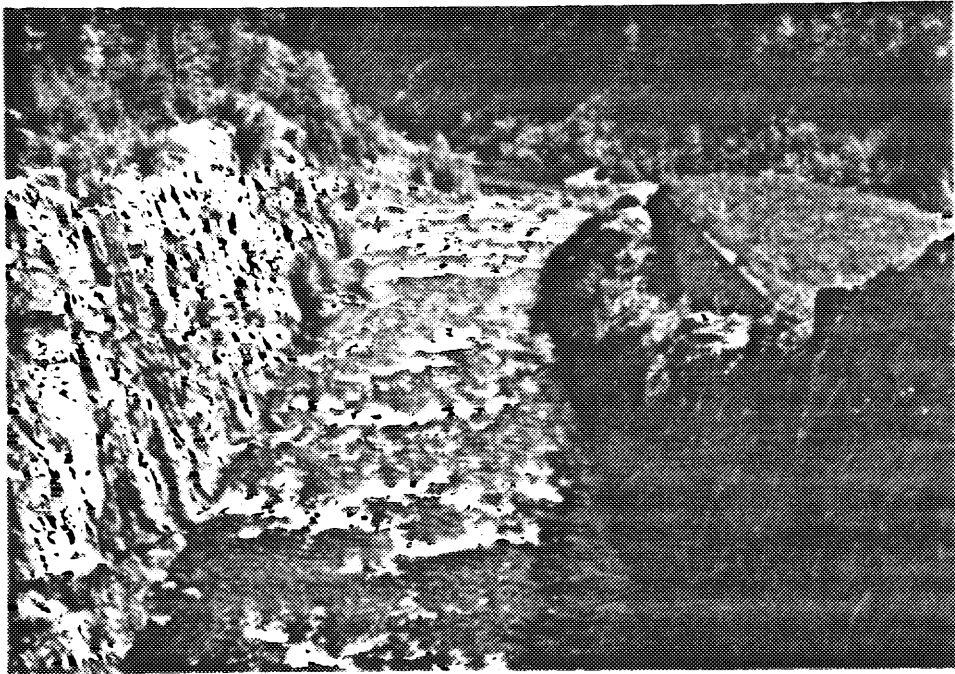


PHOTO 5
SPILLWAY CHANNEL

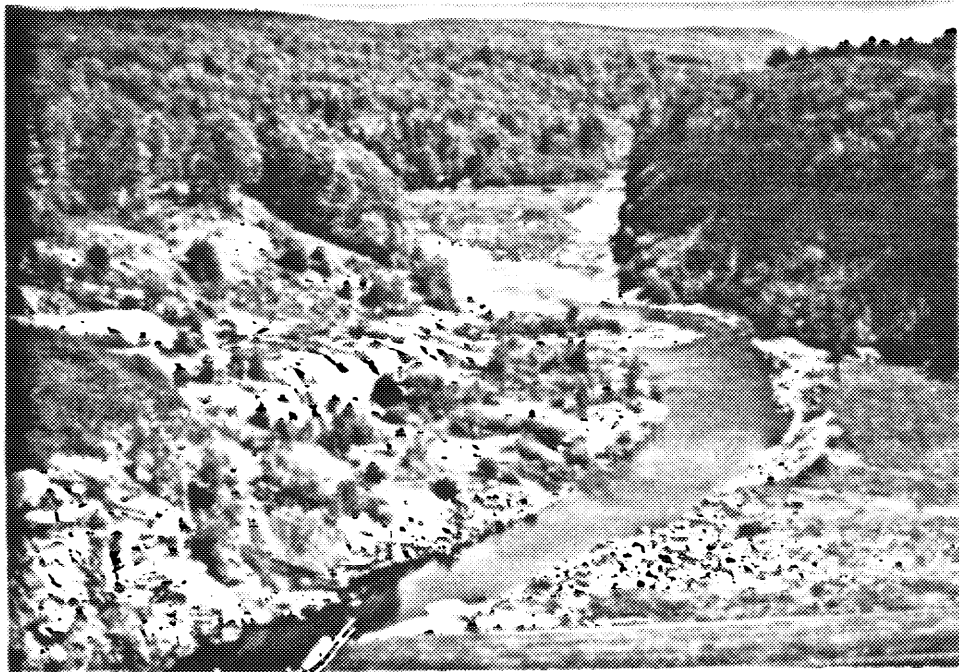


PHOTO 6
DOWNSTREAM CHANNEL

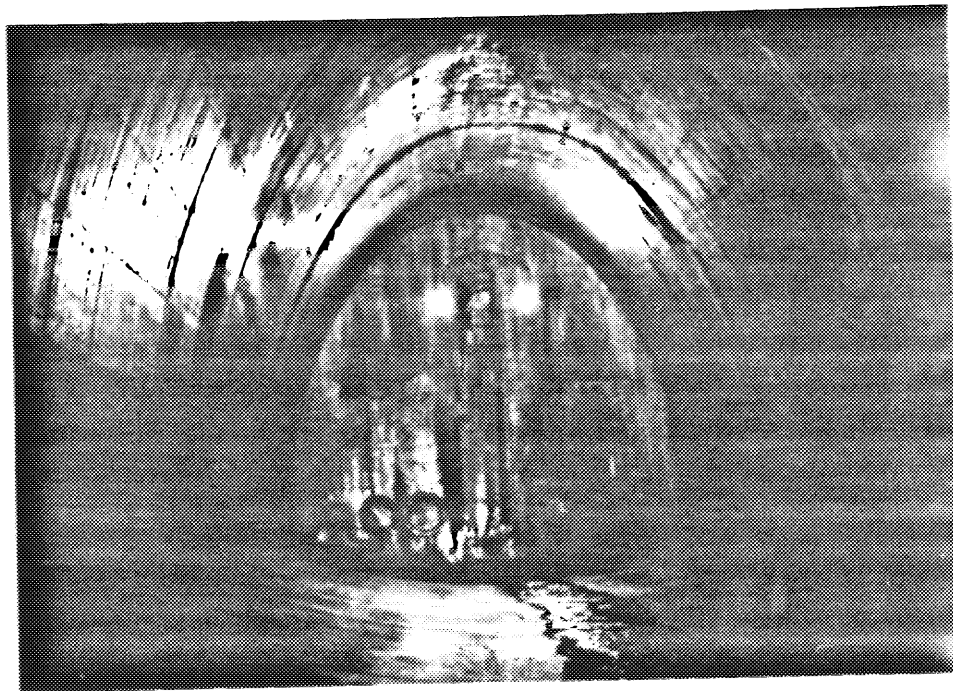


PHOTO 7
DIVERSION TUNNEL - LOOKING UPSTREAM TOWARD GATES

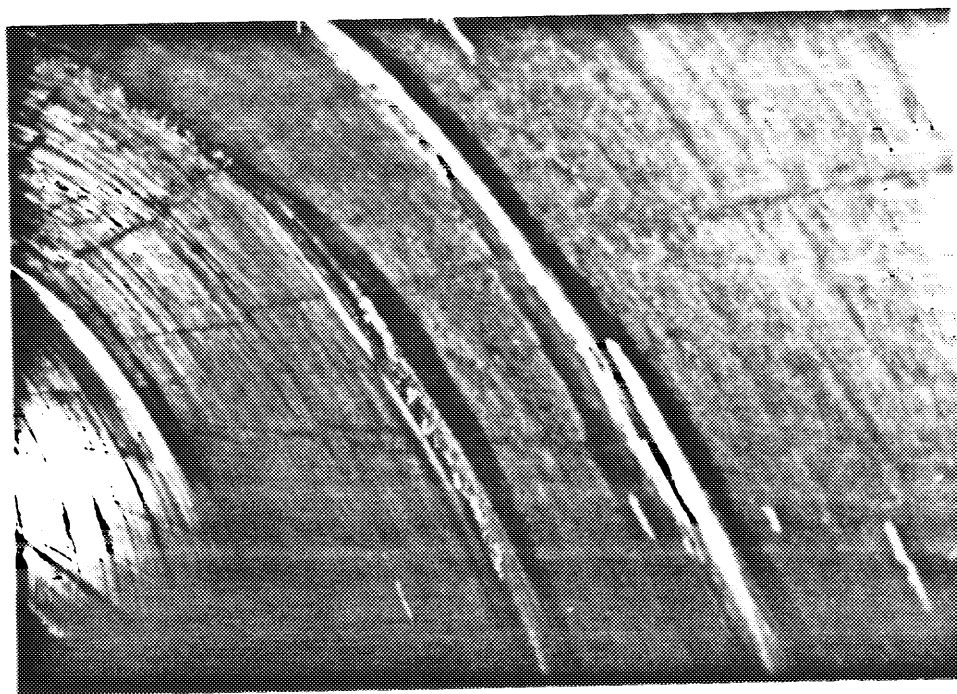


PHOTO 8
DIVERSION TUNNEL - CONSTRUCTION JOINTS



PHOTO 9

SEEPAGE OUTLET - END OF DIVERSION TUNNEL

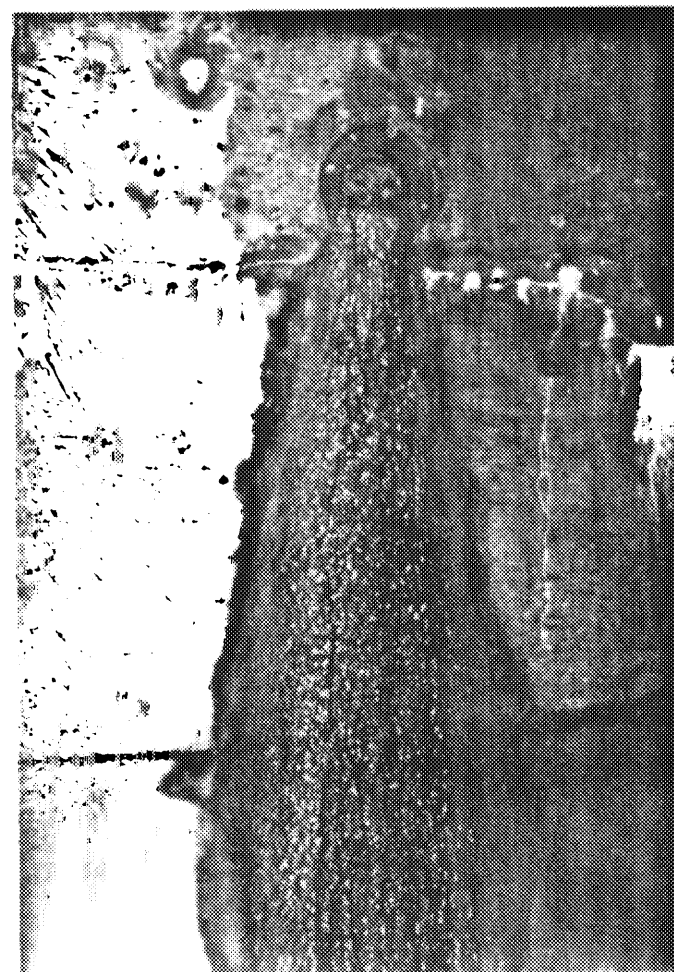


PHOTO 10

SEEPAGE OUTLET - END OF DIVERSION TUNNEL

APPENDIX D

HYDRAULIC COMPUTATIONS

D-1 to D-4

REGIONAL VICINITY MAPS

Plates 6, 7 & 8

STORCH ENGINEERS
Engineers - Landscape Architects
Planners - Environmental Consultants

"RULE OF THUMB" GUIDANCE FOR ESTIMATING DOWNSTREAM DAM FAILURE HYDROGRAPHS

I Section @ Dam

- ① $S = 17,680 \text{ Ac-ft}$
- ② $Q_{P1} = 8/27 W_b \sqrt{S} Y_0^{3/2} = 8/27 (320) \sqrt{32.2} (125)^{3/2} = 751,915 \text{ cfs}$
- ③ see stage discharge sheet

II Section @ Rte 20 - Riverton (443)

- ④ A. $D_2 = 41.5'$, $A_2 = 28,000 \text{ ft}^2$
 $L_1 = 11,500'$
 $V_1 = 7,390 \text{ Ac-ft}$
- B. $Q_{P2} = 751,915 (1 - 7390/17680) = 437,625 \text{ cfs}$
- C. $D_2 = 31.5'$, $A_2 = 17,600 \text{ ft}^2$
- D. $A_{avg} = 22,800$, $V_{avg} = 6020 \text{ Ac-ft}$
 $Q_{P2} = 751,915 (1 - 6020/17680) = 495,890 \text{ cfs}$
 $D_2 = 34'$, $A_2 = 19,200 \text{ ft}^2$

III Section @ American Legion State Forest (450)

- ④ A. $D_2 = 34'$
 $A_2 = 19,200'$
 $L_2 = 12,000'$
 $V_2 = 5,290 \text{ Ac-ft}$
- B. $Q_{P3} = 495,890 (1 - 5290/17680) = 347,520 \text{ cfs}$
- C. $D_3 = 28.5'$, $A_3 = 13,920 \text{ ft}^2$
- D. $A_{avg} = 16,560 \text{ ft}^2$, $V_{avg} = 4,560 \text{ Ac-ft}$
 $Q_{P3} = 495,890 (1 - 4560/17680) = 367,990 \text{ cfs}$
 $D_3 = 29.5'$, $A_3 = 14,880 \text{ ft}^2$

IV Section @ Rte 318 Crossing, Pleasant Valley (408)

- ④ A. $D_3 = 29.5'$, $A_3 = 14,880 \text{ ft}^2$, $L_3 = 10,000'$
 $V_3 = 3,416 \text{ Ac-ft}$
- B. $Q_{P4} = 367,990 (1 - 3416/17680) = 296,890 \text{ cfs}$
- C. $D_4 = 27'$, $A_4 = 12,000 \text{ ft}^2$
- D. $A_{avg} = 13,440 \text{ ft}^2$, $V_{avg} = 3,085 \text{ Ac-ft}$
 $Q_{P4} = 367,990 (1 - 3085/17680) = 303,780 \text{ cfs}$
 $D_4 = 27.6'$, $A_4 = 13,700 \text{ ft}^2$

STORCH ENGINEERS
Engineers - Landscape Architects
Planners - Environmental Consultants

V Section @ Rte 44 Crossing, New Hartford

④ A. $D_4 = 27.6$, $A_4 = 13700 \text{ ft}^2$ $L_4 = 22,000'$

$V_4 = 6920 \text{ Ac-ft}$

B. $Q_{p5} = 303,780 (1 - 6920/17680) = 184,880 \text{ cfs}$

C. $D_5 = 22'$ $A_5 = 7520 \text{ ft}^2$

D. $A_{avg} = 10610 \text{ ft}^2$ $V_{avg} = 5385 \text{ Ac-ft}$

$Q_{p5} = 303,780 (1 - 5385/17680) = 211,254 \text{ cfs}$

$D_5 = 23.5'$ $A_5 = 8640 \text{ ft}^2$

VI Section @ Rte 179 Crossing, Collinville

④ A. $D_6 = 23.5$ $A_6 = 8640$ $L_6 = 23,000'$

$V_6 = 4561 \text{ Ac-ft}$

B. $Q_{p6} = 211,254 (1 - 4561/17680) = 156,755 \text{ cfs}$

C. $D_6 = 20.5'$ $A_6 = 5920 \text{ ft}^2$

D. $A_{avg} = 7280 \text{ ft}^2$ $V_{avg} = 3844 \text{ Ac-ft}$

$Q_{p6} = 211,254 (1 - 3844/17680) = 165,320 \text{ cfs}$

$D_6 = 21.5'$ $A_6 = 6560 \text{ ft}^2$

VII Section @ NY, NH & H RR Crossing, River Glen

④ A. $D_7 = 21.5'$ $A_7 = 6560 \text{ ft}^2$ $L_7 = 37,000 \text{ ft}$

$V_7 = 5572 \text{ Ac-ft}$

B. $Q_{p7} = 165,320 (1 - 5572/17680) = 113,220 \text{ cfs}$

C. $D_7 = 18'$ $A_7 = 4800 \text{ ft}^2$

D. $A_{avg} = 5680 \text{ ft}^2$ $V_{avg} = 4824 \text{ Ac-ft}$

$Q_{p7} = 165,320 (1 - 4824/17680) = 120,210 \text{ cfs}$

$D_7 = 19'$

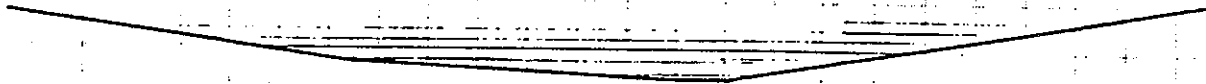
STORCH ENGINEERS
Engineers - Landscape Architects
Planners - Environmental Consultants

TYPICAL SECTION- FARMINGTON RIVER

$$V = \frac{1.486}{n} R^{2/3} S^{1/2}$$

$$S = .0028$$

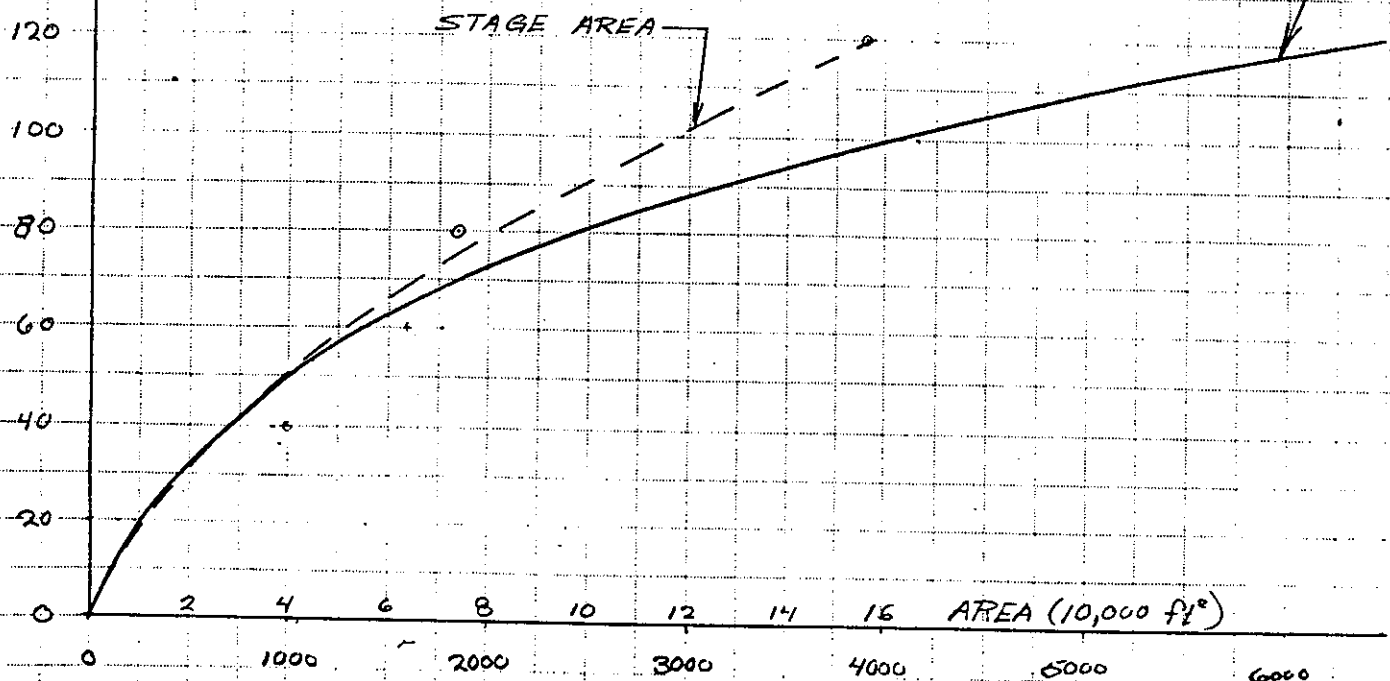
$$n = .035 \text{ (ave)}$$



D_m	W_m	A_m^2	R	$R^{2/3}$	$S^{1/2}$	V_{fps}	Q_{cfs}
10	300	2000	6.67	3.54	.0527	7.92	15,840
20	590	9600	16.27	6.43	.0527	14.4	13,8240
40	1230	40,000	32.52	10.2	.0527	22.8	912,000
60	1480	64000	43.24	12.33	.0527	27.62	1,767,680
80	1670	73600	44.08	12.49	.0527	27.93	2,059,151
100	1890	118,400	62.65	15.79	.0527	35.37	4,187,760
120	2100	156,800	74.67	17.75	.0527	39.76	6,234,368

DEPTH OF FLOW (ft)

STAGE DISCHARGE - FARMINGTON RIVER
UPSTREAM OF RIVER GLEN



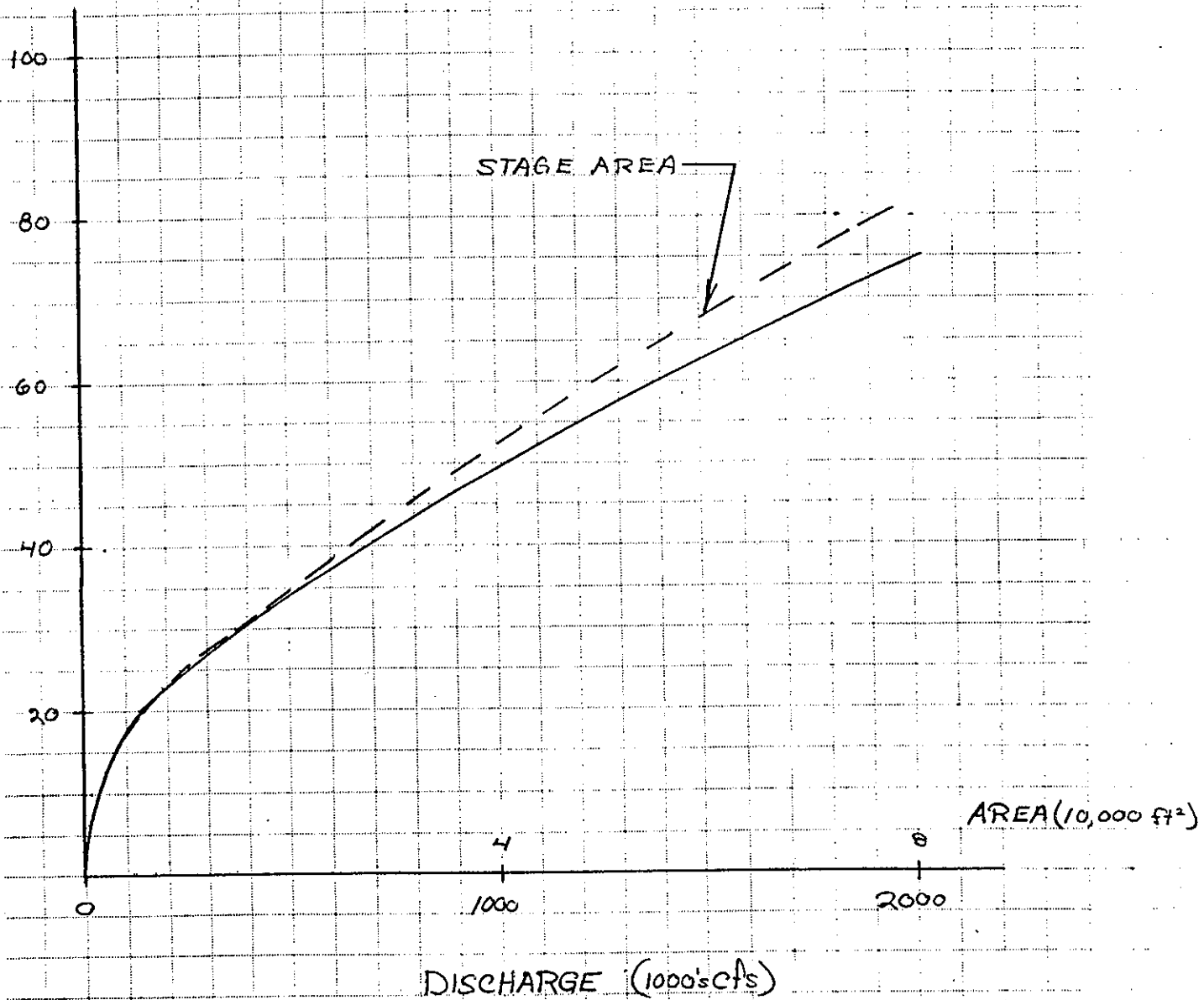
DISCHARGE (1000's cfs)

D=3

STORCH ENGINEERS
Engineers - Landscape Architects
Planners - Environmental Consultants

TYPICAL SECTION - FARMINGTON RIVER

STAGE DISCHARGE (LOW FLOW)
UPSTREAM OF RIVER GLEN-



APPENDIX E
INFORMATION AS CONTAINED IN
THE NATIONAL INVENTORY OF DAMS



INVENTORY OF DAMS IN THE UNITED STATES

STATE	IDENTITY NUMBER	DIVISION	STATE	COUNTY	CONGR. DIST.	STATE	COUNTY	CONGR. DIST.	NAME	LATITUDE (NORTH)	LONGITUDE (WEST)	REPORT DATE DAY MO YR
CT	541	NED	CT	003	06				GOODWIN DAM	4159,3	7301,2	18AUG78

POPULAR NAME	NAME OF IMPOUNDMENT
HUGSBACK DAM	WEST BRANCH RESERVOIR

REGION	BASIN	RIVER OR STREAM	NEAREST DOWNSTREAM CITY-TOWN-VILLAGE	DIST FROM DAM (MI.)	POPULATION
01	08	WEST BRANCH FARMINGTON RIVER	HIVERTON	1	300

TYPE OF DAM	YEAR COMPLETED	PURPOSES	STRUCT. HEIGHT (FT.)	HYDRAU. HEIGHT (FT.)	IMPOUNDING CAPACITIES (ACRE-FT.)
WEELPPG	1960	S	123	117	17600 13900

DIST OWN FED R PRV/FED SCS A VER/DATE
NED N N N N 16AUG78

REMARKS

D/S HAS	SPILLWAY	MAXIMUM DISCHARGE (FT.)	VOLUME OF DAM (CY)	POWER CAPACITY	NAVIGATION LOCKS
	CAEST LENGTH TYPE WIDTH (FT.)			INSTALLED PROPOSED (MW)	NO LENGTH WIDTH LENGTH WIDTH LENGTH WIDTH LENGTH WIDTH (FT.) (FT.) (FT.) (FT.) (FT.) (FT.) (FT.) (FT.)
1	800 U 900	92000	650000		

OWNER	ENGINEERING BY	CONSTRUCTION BY
METROPOL DISTRCT HARTFORD	METROPOL DISTRCT HARTFORD	WHITE OAK EXCAVATORS PLA

DESIGN	CONSTRUCTION	OPERATION	MAINTENANCE
NONE	NONE	NONE	NONE

INSPECTION BY	INSPECTION DATE DAY MO YR	AUTHORITY FOR INSPECTION
STORCH ENGINEERS	01JUN78	PL92-367

REMARKS